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The report of the president *pro tem* of the American Telephone and Telegraph Company, presented to the stockholders at their recent annual meeting and printed in last week's issue of the ELECTRICAL REVIEW, is one of the most interesting documents that has been made public for a long time. The statistics contained in it concerning the growth and extent of the Bell telephone business in the United States are of extraordinary interest, and some of the averages attract attention because of their unexpectedness. The increase in the company's business during the year 1900 was marked especially in the mileage of wire put up. This has increased over 300,000 miles, the total mileage at present being 1,354,202, or more than five times the distance from the earth to the moon.

ELECTRIC RAILWAYS ON A GREAT SCALE.

The development of the electric railway in this country has resulted in an almost complete standardization of the street and inter-urban railway systems along the well known lines, employing direct current at from 500 to 600 volts and using axle suspended motors, working through a single reduction gearing to the axles. Our neighbors on the other side of the Atlantic have recently been experimenting with more or less success with alternating-current systems of distribution and operation for electric railways.

In this country the alternating-current system has been used for distribution with great success, in many cases where long lines have to be operated from a single station, but hitherto practically no effort has been made to operate polyphase motors directly upon moving cars. This is notwithstanding certain exceedingly important features which are noticed in connection with the working of these motors, and also notwithstanding the extraordinary simplicity and cheapness of methods of distribution and generation employed for these currents. The induction motor has been highly perfected and is to-day as reliable as the direct-current motor, while far more simple. In consequence there has been much argument in regard to the equipment of moving trains with motors of this type.

It may be of interest to describe at some length the advantages and disadvantages of the polyphase system as contrasted with the direct-current system for this purpose. In the first place no polyphase system can be conducted with less than three conductors. In the case of a railway this means two working conductors and the track, or else three conductors suspended above the track or installed as additional conducting rails. In either case the difficulties involved in switching and in crossing become of the greatest importance and, so far, there has not been proposed an entirely practicable solution for this problem. In heavy railway work, especially, it is necessary for the trains to have full power in passing turn-outs or upon switches, and all who can remember the experience with the early double trolley direct-current roads will understand that even with low pressures the switch problem will be one of great difficulty.

Another obstacle in the way of the success of polyphase systems is the fact that induction motors have a bad power factor, especially when the air-gap in them is large. The conditions under which railway motors, of whatever type, are operated are such as to necessitate a comparatively large air-gap and thus, by reducing the power factor of the machines, to nullify in large measure the advantage gained by ease of conduction and the employment of high voltages.

The third disadvantage of the induction motor is that it is in its operation essentially similar to the shunt motor and does not possess the qualities of powerful torque at starting and ability to give high acceleration to the train which is so admirably shown in the direct-current series motor. These three disadvantages are practically all that beset the polyphase machine.

On the contrary, its advantages are numerous and important. It has no commutator and thus the weakest point in the ordinary electric railway system is immediately removed. In the second place, since its control can be accomplished entirely by manipulation of the secondary current in it, any voltage which safely may be insulated can be employed upon the trolley line and led directly into the primary circuit of the machine without endangering in any way the operatives who control it. This permits very high voltages to be used, with a corresponding saving in the cost of copper and a lower-

ing of the fixed charges for interest on the plant.

In the third place the induction motor, unlike the direct-current machine, is easily made to restore power to the line when the train is running down hill, and in large installations comparatively well loaded, this restoration of power may effect a saving of 30 or 40 per cent of what would be required were the operation of the railway by direct current. Taking, therefore, these advantages into consideration, it is evident that there is room for the serious study of the polyphase railway question so that the great advantages enumerated may be availed of while the disadvantages may be set aside.

How to overcome the trouble with the double or triple conducting system is the principal question involved. It is quite possible to foresee methods by which the bad power factor difficulties may be combatted with success, and on certain classes of railways heavy starting torque is by no means so necessary as powerful working torque and ability to climb hills at full speed. The whole question really simmers down to a discussion of the best method of operating a double or triple trolley system upon which high voltage is employed. Upon the solution of this problem probably rests the future of alternating-current electric railway practice; and upon the development of a proper alternating-current system of railway propulsion rests the still greater question of the electrical equipment of existing main line steam railways.

THE MECHANIC OF THE FUTURE.

The consensus of opinion among intelligent foreign observers of our industrial situation is that a large proportion of the extraordinary advance in American industrial activity has been due to the character of the worker in our shops and factories. The American mechanic has for a long time stood as a type of what is best in his line and, to-day, probably there are no better workers, no more skillful and efficient operatives in the world than we have at our command in the great shops and industrial enterprises of the United States. These men are the result of a system which unconsciously has produced a type of operative greatly superior to any other that has yet appeared. The system of apprenticeship and direct instruction in the shops, combined with free education and the payment of a sufficient wage to enable the laboring man to enjoy the benefits of culture and recreation elsewhere denied him, have worked together to the production of the superior product known as the American mechanic. The question that should now be prominently before our manufacturers and others who employ labor is: What methods shall we take to perpetuate this stock, and how shall we best educate the rising generation to take the place of those who are our industrial bulwark to-day?

That this question is not receiving proper consideration in many quarters is painfully evident to any one who will make a tour of inspection of our great industrial enterprises. The apprentice system is practically dead and so far nothing seems to have appeared that can fully take its place. Schools of technology are springing up in many quarters, and no one can deny that the young men graduated from them have a certain foundation of knowledge which may be in the future beneficial to them. But the requirements of our shops are not to be satisfied by the graduates of schools of handicraft and technology; what the shop wants is experienced men, and the main question is, where can the man get the experience before he comes to the shop to sell it?

One thing is very certain and that is that he can not get the experience that is necessary to him in the school. With the proper opportunity to put into practice his knowledge after leaving school he will become in a few years a mechanic of the very best and highest type; but without this opportunity—and too often poverty prevents the seizing it—he is of little value when he first comes seeking employment. Certain influences have worked strongly in this country for the abolishment of the apprentice system, but their policy has been short-sighted and the result, it is feared, will be seen in the industrial situation of the United States within the next generation.

The subject is one worthy the close and careful attention of all men who are interested in the maintenance of our industrial supremacy and of our great manufacturing trade. Manufactures can not be carried on without men and the necessity for good men is daily growing stronger. It is true that each labor-saving machine that is installed takes the place of a certain number of operatives, but it is equally true that the operation of these labor-saving machines themselves calls for intelligence and skill of a higher grade, and absolutely necessitates the presence in every shop where they are used of mechanics trained in the best tradition of their art. Where are these men to come from in the future, and what can we best do to train the boys now about to enter employment so that the race may be perpetuated?

It would be a crime were the American mechanic to be allowed to become extinct. Yet to the studious observer it is evident that nothing short of extinction menaces him in the industrial situation as we see it to-day. This unfortunate condition is by no means the result of any premeditated plan, but is the outgrowth of conditions which have been brought about in the effort to better the condition of working men by both men and employers. In opposing the policy of employing apprentices the labor unions have not looked far into the future, but have struck a mortal blow at the industries upon which the descendants of their members must live. No doubt by this time the error of this point of view has become widely recognized, and it is likely that if manufacturers should take some definite step toward introducing the apprentice system largely again, and providing in some way for the instruction both in handicrafts and in the studies pursued generally in schools of a sufficient number of boys and young men, the result would be admirable, and the fine race of mechanics that has distinguished this country would flourish rather than fall into the decline preceding extinction. We have only to look across the Atlantic at England to see the condition here referred to in a little further stage of development. The picture is by no means a pleasing one, and it seems time for the manufacturers in this country to act in order that their future salvation may be secured.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—XXII.

BY W. ELWELL GOLDSBOROUGH.

By a further adjustment a new modification may be introduced. When L_1 was reduced to zero the circuit OA_1 became non-reactive. In this condition, however, it contains an infinite capacity in series with the resistance r_1. This may be diagrammatically represented by inserting the condenser C_1 in the circuit, as shown in Fig. 61. So long as the condenser has an infinite capacity its presence is not felt, but immediately upon its capacity being reduced a marked change is noticeable in the vector diagram illustrating the capacity effects. If a moderate reduction in the condenser capacity is made there is immediately in evidence a reactance electro-motive force that diametrically opposes the inductive reactance electro-motive force of the circuit A_1A, Fig. 61. In Fig. 63 this condenser reactance electro-motive force is shown as the vector C_3A_3. In other words, the effect of the variable capacity C_1 is to neutralize the reactive effect of the constant inductance L_2, thereby reducing the total reactance of the circuit and bringing the current more nearly into phase with the impressed electro-motive force E. In Fig. 63 this initial change in C_1 causes the heel C of the electro-motive-force triangle to move up to the position C_3, since

$$\frac{x_1 - x_2}{r_1} < \frac{x_2}{r_1},$$

and the lag of the current behind OA is diminished. Thus the resistance electro-motive force continues to increase along the vector locus $OC_1C_2CC_3$ of Figs. 62 and 63, and the current increases still further along the locus $OB_1B_2BB_3$. Consequently, since it has already been shown that $I\,x_2$ changes proportionally to I, the reactance electro-motive vector of the circuit A_1A continues to increase along the periphery of the locus circle $AA_1A_2CA_3$, and in the present instance has a value equal to A_3A. The resultant reactance electro-motive force of the system is equal to

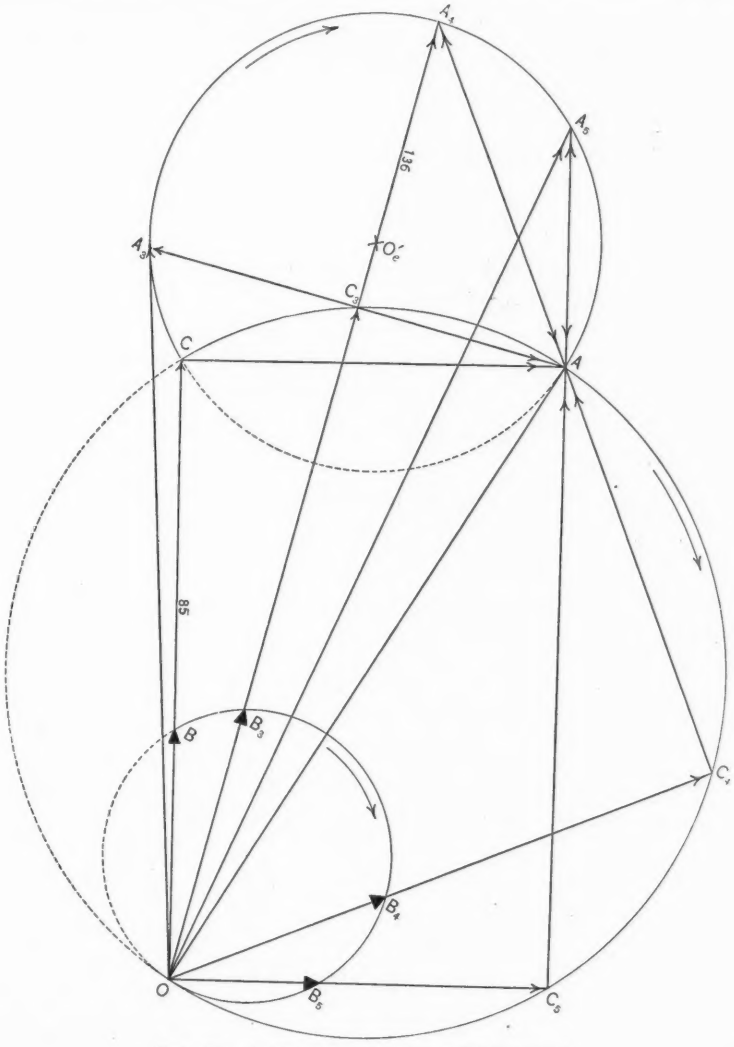


FIG. 63.—ALTERNATING-CURRENT MECHANISMS.

$$I\,x_1 - I\,x_2 = C_3A_3 - A_3A = C_3A.$$

In the present instance the value of x_1 is so chosen that

$$2\,I\,x_1 = I\,x_2$$

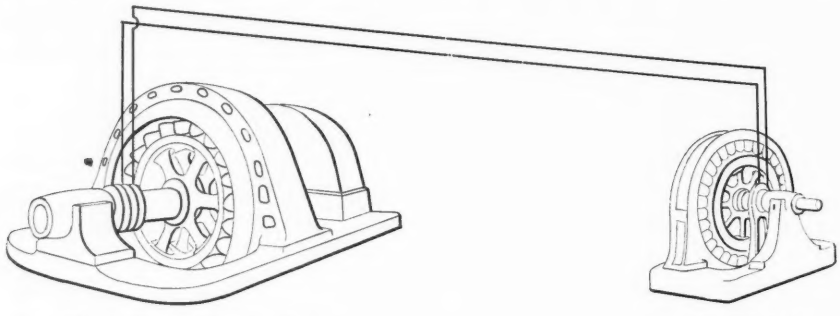
therefore the resistance electro-motive-force vector OC_3 bisects the line A_3A and the angle A_3OA. But by construction OA is tangent to the locus circle $AA_1A_2CA_3$ at A, therefore OA_3 is tangent to this locus circle also at the point A_3 and, moreover, OA_3 is equal to OA, or the electro-motive force acting upon the circuit OA_1, Fig. 61, is equal to the impressed electro-motive-force E. Again the current is just as far in advance of the vector OA_3 as it lags behind the vector OA.

If the capacity C_1 is made still smaller the point C will move farther and farther up along the curve until it reaches and even passes the point A. Similarly, the current vector will constantly move over from the left to the right until OB not only reaches a position of coincidence with OA but passes it to take the position OB_4 in advance of OA. In the latter event the resistance electro-motive force will have attained a value and phase position equal to OC_4; and as $I\,x_2$ is always 90° behind OC_4 and proportional to the current its vector will be in the position A_4A, the change in the value of C_1 having advanced the vector head at A_3 to the point A_4. The reactance electro-motive force of the condenser is now completely in excess of the reactance electro-motive force of the induction coil, Fig. 61, since the former has a value C_4A_4, while the latter has a value of only A_4A. This makes their difference equal to the vector C_4A, which is now the resultant reactance electro-motive force of the system.

The last change in the capacity caused a great change in the electro-motive force acting on the circuit OA_1, Fig. 61. Since it is equal to the resultant of $I\,r_1$ and $I\,x_1$ at all times it now has a value equal to OA_4, which is 36 per cent greater than the impressed electro-motive-force E. This is the greatest electro-motive force which can occur in the circuit under the given conditions, as it marks the position in which the vector OA_4 passes through the centre of the locus circle $AA_1A_2CA_3A_4A_5$. It has already been pointed out that OA_2 is the least electro-motive force that can exist around the circuit OA_1, Fig. 59, and OA_2 is in phase with OA_4, therefore the diameter AK, Fig. 62, of the locus circle represents the range of the voltage variation at the terminals of the circuit OA_1.

The maximum value that $I\,x_1$ can attain to for any value of x_1 occurs when A_4 has advanced to such a position that $I\,x_1$ is in phase with the phase position of $I\,r_1$ when

$x_1 = 0$. If, therefore, we draw through A a line parallel to OC, the vector C_5A_5 is determined and measures the maximum value of I x_1. At this time the value of the current OB_5 is small and approaching zero for still smaller values of C_1. When finally, therefore, $C_1 = 0$ the current vector will have passed to its zero value, and its vector head completed the circumference of the current locus circle. In the same manner the reactance electro-motive force will have completed the periphery of its locus circle and the reactance electro-motive force I x_2 will have made a revolution around the locus circle having its centre at O^1_e.



Element G: An Alternating Current Generator

Element M: A Synchronous Motor

FIG. 64.—ALTERNATING-CURRENT MECHANISMS.

In Figs. 62 and 63 we have a graphical representation of the formula

$$I = \frac{E}{\sqrt{r_1^2 + (x_1 - x_2)^2}} \qquad (187)$$

in which E, (r_1) and (x_2) are constants, with $x_2 = L_2\,\omega$, and (x_1) has values ranging from $-\infty$ to $+\infty$. When $x_1 = -\infty$, (x_1) is an inductive reactance with $L_1 = \infty$, and when $x_1 = +\infty$, (x_1) is due to a capacity $C_1 = 0$. Data for the construction of the figures can be obtained by direct substitution of suitable values in (187), and in Example 13 is given the results of such work.

Figs. 62 and 63 are typical of numerous phases of practical commercial working with alternating-current machinery in the distribution and transmission of power and their direct application to such practical problems will presently be presented.

Example No. 13.

Given: A commercial circuit consisting of two principal elements G and M. Element G has a constant inductance of .041 henry and a negligible resistance, element M has a variable reactance ranging from a very high inductive value, through zero, to a very high capacity value. The resistance of element M is also negligible but it is connected with element G by a transmission line having a resistance of 25 ohms. An alternating electro-motive force of 1,000 volts at a frequency of 60 cycles per second influences the system.

Determine the vector diagrams of the circuit when the reactance of the element M has the values 49 ohms, 18.5 ohms, *zero* ohms, 7.8 ohms, 33.8 ohms and 52.8 ohms, respectively.

By direct substitution in equation (187) the value of the current that will flow in the circuit under each condition of the reactance of the element M is readily determined. Having knowledge of the several current values the electro-motive forces in the several parts of the circuit are easily calculated as the

Line electro-motive force

$$= E_r = I\,r_1$$

The reactive electro-motive force of the receiver M

$$= E_M = I\,x_1$$

The electro-motive force *a c* cross the line and receiver M

$$= \sqrt{E_r^2 + E_M^2} = E_1$$

The reactive electro-motive force of element G

$$= E_G = I\,x_2$$

The resultant reactive electro-motive force of the system

$$= I\,(x_1 - x_2) = I\,x = E_x$$

These are tabulated in Table 5, and several sections of Figs. 62 and 63 show the exact vector diagrams corresponding to the several sets of data.

The first set of values determined from $x_1 = 49$ are shown in Fig. 62, when

$$OB_1 = I = 14.5 \text{ amperes.}$$
$$OC_1 = E_r = 362 \text{ volts.}$$
$$C_1A_1 = E_M = 711 \text{ volts.}$$
$$OA_1 = E_1 = 794 \text{ volts.}$$
$$A_1A = E_G = 225 \text{ volts.}$$
$$C_1A = E_x = 936 \text{ volts.}$$

In this case, since the cosine of the angle of phase difference between the impressed electro-motive force and the current is equal to the ratio of E_r and E, we have

$$\cos \phi = .362 \text{ and } \phi = 68°.$$

In this instance the current lags 68° behind the impressed electro-motive force.

The second set of values, in a similar manner, determines the positions of the vector heads, B_2, C_2 and A_2, and thereby locate in correct position the various vector quantities.

The "blank" set of values locates this simple vector triangle OCA, as the value of x_1 is *zero*, and therefore

$$OB = I = 34 \text{ amperes.}$$
$$OC = E_r = E_1 = 850 \text{ volts.}$$
$$CA = E_M = E_x = 528 \text{ volts.}$$

In this case the lag of the current is 32°.

As the third, fourth and fifth sets of values are quite similar, only the fourth will be considered in detail. Here

$$OB_4 = I = 32.3.$$
$$OC_4 = E_r = 804.$$
$$C_4A_4 = E_M = 1091.$$
$$OA_4 = E_1 = 1356.$$
$$A_4A = E_G = 502.$$
$$C_4A = E_x = 589.$$

And it is seen that a very high voltage occurs across that part of the circuit which embraces the receiving element and the line; and that in spite of the line "drop" of 804 volts the electro-motive force at the terminals of the receiving element is 1,091 volts, or 91 volts greater than the total electro-motive force impressed on the system. In this case the current is 36° in advance of the impressed electro-motive force.

The problem points out very clearly the compounding effects that may be produced by taking advantage of the conditions existing in a distributing system and using them to promote constant pressure regulation at receiving stations distant from the point of supply.

TABLE 5.

DATA PERTAINING TO EXAMPLE NO. 13.

Subscript. No.	Henrys. L_1.	Micro-farads. C_1.	Ohms. x_1.	Amperes I.	Volts. I r_1.	Volts. I x_1.	Volts. E_1.	Volts. I x_2.	Volts. I x.	Ohms x.	Degrees ϕ	Subscript. No.
1	.130	∞	49.0	14.5	362	711	794	225	936	64.5	68	1
2	.049	∞	18.5	23.6	591	437	737	367	804	34.0	54	2
.....	0	∞	0	34.0	850	0	850	528	528	15.5	32	.....
3	0	340	7.8	38.2	954	298	1,000	596	298	7.8	17	3
4	0	79	33.8	32.3	804	1,091	1,356	502	589	18.3	36	4
5	0	47	55.6	21.1	528	1,174	1,286	327	847	40.1	58	5

ELECTRICAL PLANT OF THE CURTIS PUBLISHING COMPANY, PHILADELPHIA, PA.

BY JOHN S. GRIGGS, JR.

When the history of the great industrial development just taking place is written it will be found that it is really a history of electrical equipment in most cases, making possible the great savings and increased outputs which enable us to outdo the rest of the world. One of the fields in which most rapid strides are being made is in printing, and the new mechanical plant of the Curtis Publishing Company, in Philadelphia, is one of the largest and most complete in this country.

The requirements of printing-press control are somewhat peculiar. When putting on plates or "making up," the machine requires to be moved a fraction of a revolution; when starting the press or putting the paper through, as in rotary presses, the speed must be very slow; when ready for operation it should be run slowly for a few moments to make sure of smooth operation; the best running speed is not a fixed quantity, depending on condition of ink, quality of paper, etc., and yet this running speed should always be the very highest possible, to get the maximum output, and, of course, variable at will. No other power can approach electricity for this purpose, both as to its great convenience and perfect control, and its economy. Belt-driven machinery, with either single or cone pulleys, is unsatisfactory and consumes an enormous amount of power in transmission, whether the presses are being operated or standing still. Friction driving is very expensive and inefficient. Separate engines on each machine are very wasteful in their use of steam, including the large losses by condensation in the lines, besides being extremely high in first cost.

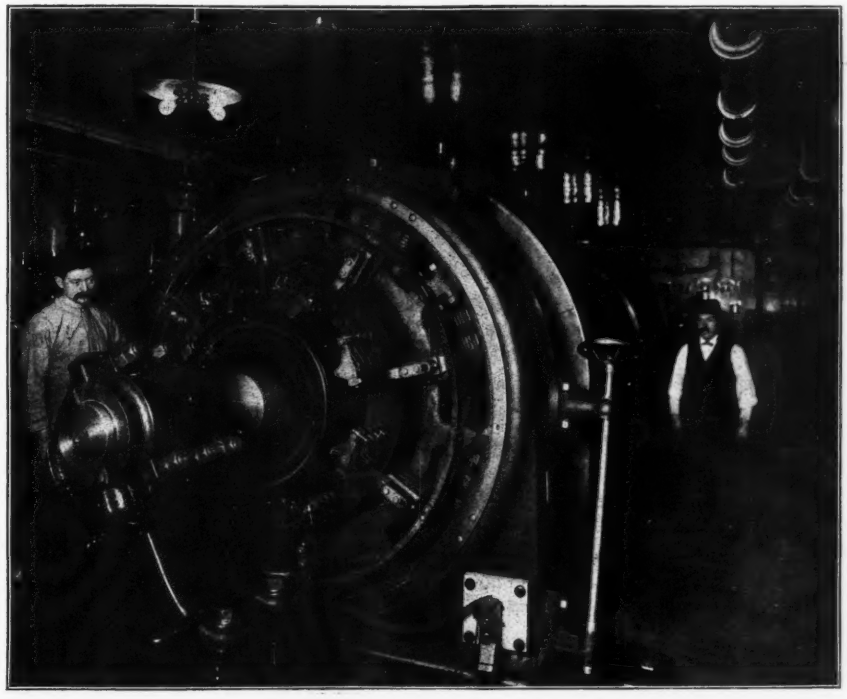


FIG. 1.—A VIEW IN THE ENGINE ROOM.

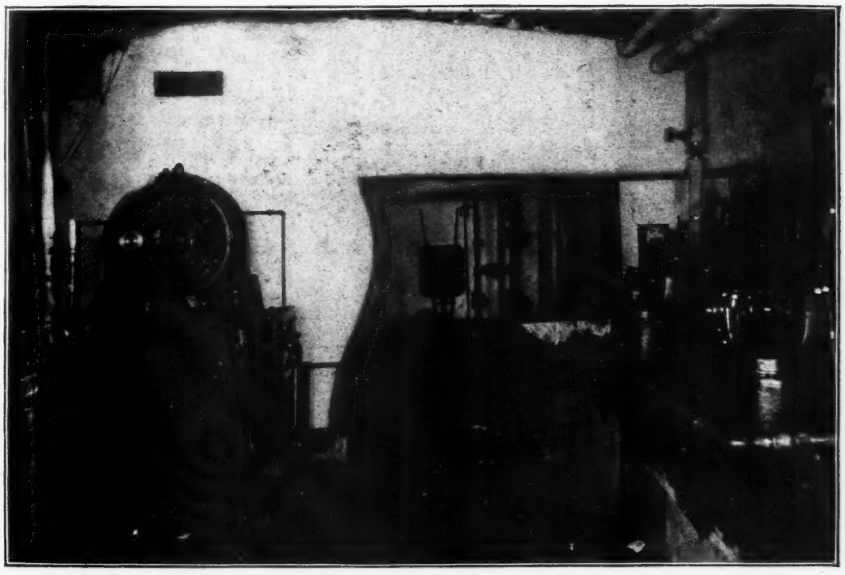


FIG. 2.—MECHANICAL DRAFT PLANT.

In manufacturing establishments of any character when the power is transmitted from a single engine by means of shafting, belting, gearing, etc., in what was formerly considered the best method, the amount of power required to keep this transmission machinery in motion is a large percentage of the maximum power of the engine; this friction load is seldom less than 40 per cent and is often as high as 75 per cent of the total power developed; it is almost a fixed quantity, and is just as great a source of loss when the shop is running at one-third or one-half capacity as when turning out the maximum. With the electric drive there is, of course, a small loss between the engine and the point where the power is applied, but in a properly designed system this loss, with everything running, is less than the friction loss in a belted system, but this electric loss is proportionately cut off when the various machines or departments are shut down, and does not remain a drag on the generating plant. Such a system permits the operation of one department, or an isolated building, when necessary, and only that power is developed which is actually required. With two or more generating units in the power plant the load, whether large or small, can be taken care of advantageously, always running the unit or combination of units best suited to the requirements. In a business where it is often necessary for any reason to run some department for a few extra hours to catch up, or to provide for rush orders, this is of great advantage. Where belts and shafts are used the main steam plant must be at least twice as large as with the electric drive to provide the power to overcome the friction loss. So when all the elements of both methods are considered it is found that the first

cost of the electric system is really less, cutting down the size of the power plant, and taking out the belts, line and countershafts on one side, and on the other adding the generators, motors and wiring. This is a fact which the writer has demonstrated in several factories, but one which is frequently overlooked. Taken in connection with the great economy in operation of the electric drive it is the strongest possible argument for the latter modern method.

The plant we are considering consists of a new mechanical building, seven stories high, running through from Appletree to Cherry street, occupying a lot 80 feet wide and 180 feet deep, between Fourth and Fifth streets. It is directly in the rear of the executive building of the company, which extends through the block from Arch to Appletree street. The latter has been occupied for seven or eight years. The new building contains the printing and binding department on the first four floors; the fifth and sixth floors are given up to the mailing department and storage space for the monthly magazines, which are printed constantly during the month and stored until sent out to all parts of the country, at the proper time, to be issued simultaneously. The seventh floor is occupied by the typesetting and composing rooms, etc. It was desired to retain the basement of this building for paper storage, which necessitated placing the power plant in the basement of the executive building. This developed a number of puzzling questions, and made the installation of the machinery a much more difficult operation than usual in such cases. The power plant is designed to furnish light, heat and power to both buildings. The old building had 800 incandescent lamps, two electric elevators, ventilating fans, etc. The new building has two 6,000-pound freight elevators, about 600 incandescent and 125 enclosed arc lamps, besides all the machinery. Before designing the generating plant a very careful investigation was made of the power required for the various machines. This information was secured by taking readings from similar machines, electrically operated, in the old pressroom, from previous experience and from a number of other sources. Combining all data and making allowance for natural growth to be taken care of by the power plant without increase, the plant was designed. It consists primarily of a three-unit plant; any two units are amply large to take the maximum load, leaving the third idle for any emergency. Machinery is no more infallible than the best of

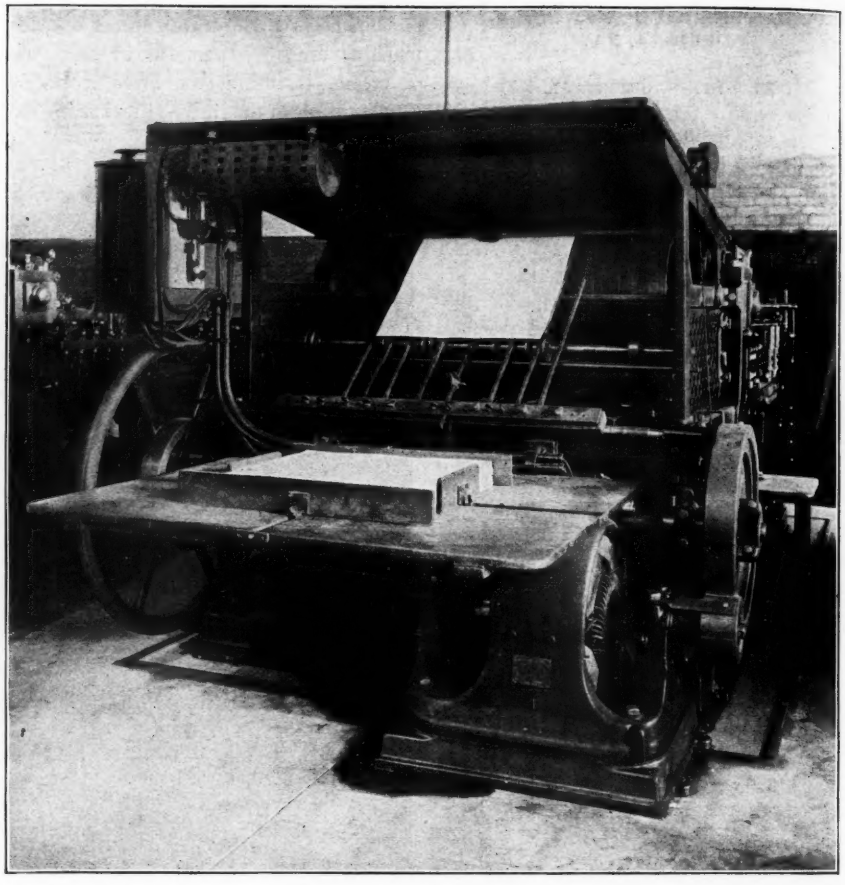


FIG. 3.—CYLINDER JOB PRESS.

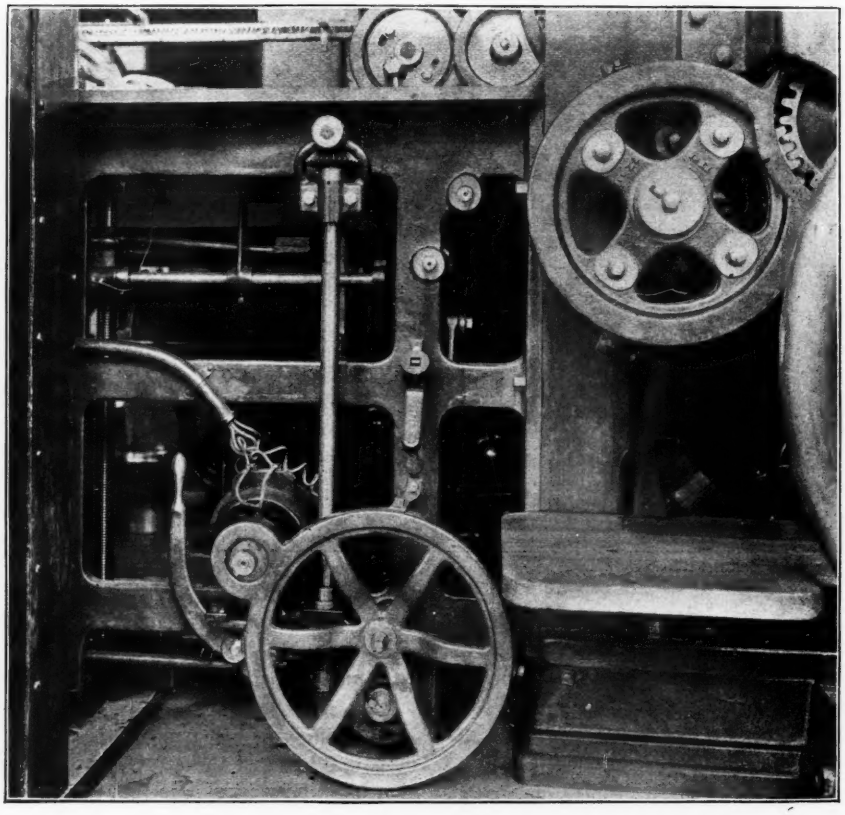


FIG. 4.—SMALL MOTOR ON ROTARY PRESS.

FIG. 5.—ELECTRICALLY DRIVEN PAPER CUTTER.

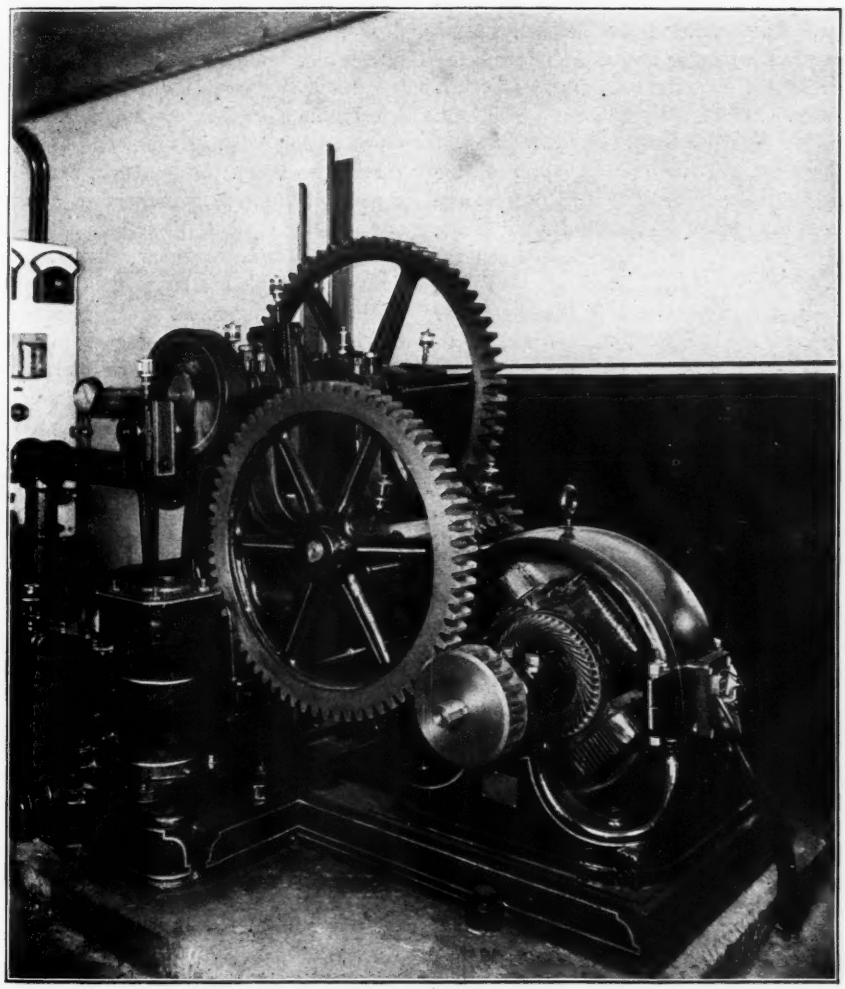


FIG. 6.—ELECTRIC HOUSE PUMP.

men, and the third unit provides for occasional lapses which might otherwise prove disastrous, for a regular publication *must* come out on time and the subscribers do not wait, either patiently or silently, when their magazines are not received promptly.

In order to obtain the space necessary for the power plant the rear elevator, which ran to the basement, was stopped at the street level, and the electric elevator machinery taken out and replaced by an electro-hydraulic machine, driven by a Quimby screw pump, located alongside the second elevator machine in the front end of the basement; a plunger elevator, running from the basement to the rear sidewalk, takes the place of the former car, which ran all the way down, and is operated by the same pump. It is used to handle ashes, etc.

The steam plant consists of three Babcock & Wilcox cross-drum water-tube boilers of 250 horse-power each at a pressure of 160 pounds. In order to get them into the basement, which was not very deep, it was necessary to underpin the side walls of the building, and, owing to the supporting columns, they could not be set in a battery, but are set singly. Provision is made in the plan for adding a fourth if it should ever become necessary. The chimney in the building was originally put in for heating boilers only, and was only 30 inches by 40 inches, and about 90 feet high. It was obviously too small for a 750-horse-power boiler plant, but, owing to conditions, the owners were anxious to avoid enlarging it so that an induced draft plant became a necessity, to give draft enough in the boilers and to force the gases up the stack. In order to get the best results from such a plant a 600-horse-power Green economizer was put in between the boilers and the fans to serve the double purpose of raising the temperature of the feed-water and to reduce the volume of the gases which the fans handle. The results are more than satisfactory. The economizer reduces the coal bills from eight to ten per cent, and at the same time so cools the gases that the power required to run the fans is less than half of that used when the economizer is cut out. The induced draft plant consists of two 120-inch American fans, horizontal top discharge, so connected that either of them can be used. They are operated by eight-horse-power direct-connected electric motors, with compound controllers, and can be run at any speed from 100 to 275 revolutions per minute. As ordinarily run they require less than three horse-power, while the automatic tube scraper on the economizer,

which is only run an hour or two each day, takes less than half a horse-power.

Steam from the boilers is carried in a short 10-inch extra heavy header, running the length of the boiler room, from which run branches to the engines; immediately before entering the engine room the steam passes through a Stratton separator, one on each branch, and from the separators to the throttle valves in long bends. In the engine room are the three large units for the regular work, supplemented by a small one for the night and Sunday work, pumping, watchman's lights, etc. The three large engines are 14½ inches by 28 inches by 18 inches, Harrisburg four-valve tandem compound, running at a speed of 200 revolutions per minute, rated at 325 horse-power. The small engine is 11 inches by 12 inches, running at 275 revolutions and developing 80 horse-power. Each of the large engines is direct-connected to a 200-kilowatt, 250-volt, continuous-current Westinghouse generator, while the small one is 50 kilowatts. Current from these four generators is delivered to the main switchboard, each machine having its own panel, on which are mounted indicating and recording instruments, as well as the appliances for control. The switchboard, in addition to the four generator panels, has two feeder panels on which are mounted the station ammeter, ground detector and the distributing switches to the various departments.

In order to use the exhaust steam for heating and at the same time get the economy of compounding, some system of vacuum return was necessary to keep the back pressure off the low-pressure cylinders. For this purpose the Webster system was selected, with the result that the back-pressure line and the atmosphere line on the low-pressure indicator cards can not be separated, and the exhaust steam gauge never records more than one-quarter of a pound. The exhaust steam passes through a 600-horse-power Cookson heater before it is used around the building; it is also utilized for heating the water used for domestic purposes in both buildings; the condensation from the water-heating tanks, as well as from the whole heating system, is returned to the feed-water heater at a temperature of about 170 degrees, and the additional water necessary to keep up the boiler supply is automatically supplied from the city mains through a float valve in the heater. This incoming water is heated to about 210 degrees and mixed with the returns and fed into the boilers. To handle this water three Gould triplex, motor-driven pumps are provided. Two, having a capacity of 40 gallons each per minute, are either of them large enough to supply the normal maximum needs of the plant, while a smaller pump of 10 gallons capacity is used for night work or to supplement one of the larger ones if required. They are all provided with compound controllers, giving a variation of speed down to one-third of maximum. Pumps receive their supply either from heater or city mains, and deliver either through economizer or into boiler direct. The main exhaust is also by-passed around heater. Condensation from all high-pressure points, headers, separators, etc., is collected into a tank trap discharging into heater or blow-off tank. Low-pressure returns flow into a receiver under the floor and are delivered by a return trap to blow-off tank. A small duplex pump and receiver automatically handle these low-pressure drips if the trap fails to work, or the amount of drips is very large. Domestic water supply for both buildings is provided by two Worthington triplex pumps, one of 350 gallons and the other of 100 gallons capacity per minute. The smaller is of sufficient size to supply the regular needs, the larger being a reserve for special occasions. Their arrangement is a little unusual. The tank on the executive building is about 30 feet lower than the two on the roof of the mechanical building; the main discharge from the pumps is connected to all tanks, with a float valve which closes when the tank on executive building is filled; the water then rises and fills the upper tank on the second roof; this tank is always kept full for fire purposes, and water overflows from it into the other tank, directly below it. In this is placed the automatic float switch, which starts and stops the pump motor as the water falls or rises below or above determined limits. Mercury tell-tales in the engine room show the condition of all tanks.

An ordinance was passed by councils of the city of Philadelphia permitting the laying of a tunnel under Appletree street to carry the steam, water and electric conduits between the two buildings. For the steam and water a 30-inch cast-iron pipe was laid, extending just inside the basement wall in each building, with a "bell end" at each outlet. The electric cables are carried through a 36-duct terra-cotta conduit, made of four to nine conduits, laid in concrete.

From the switchboard the current is distributed as follows: For lighting the old building the three-wire risers, one for each floor, were converted to a straight two-wire, 220-volt system, which is the voltage used throughout for all lights and power. A feeder board for these circuits was installed in the engine room. The auxiliary machinery, already mentioned, with the addition of a ventilating fan, is all wired from a separate panel board with duplicate bus-bars also located in the engine room. In the new building two centres of distribution are provided on each floor—for both power and lighting. They are located near the end in each case, on shafts built in the wall to accommodate the cables. For supply to each of these centres cables run through the street conduit, from the switchboard to the panel in each case, so that each half-floor is controlled from the engine room. Where running under the street the cables are all lead covered, but the rest of the work is plain triple-braid cable in iron-armored conduit. All branch circuits from the panel boards are also carried in iron conduits. Lighting circuits are carried up from the panels and laid in the floor above, since the lighting is all done from the ceiling outlets, while power circuits are carried down and under the floor to the motor outlet. Each motor has its own branch circuit from the panel board and any trouble with a circuit does not disable more than one machine. Wall plugs, in columns and side walls, are provided, into which the pressman can plug a portable light to get under or around any machine when desirable. In the pressrooms and elsewhere where strong light is desirable arc lamps are used, and in the composing room, when close lighting is needed, and in storage rooms, incandescents are used, singly or in clusters.

The great advantage of the use of electric power is shown in such an installation. Here we have a plant, one of the largest of its kind in the country, with a large amount of machinery, and yet an entire absence of the usual whirring shafts and flapping belts with their dirt and noise, and none of the disagreeable shadows bound to come from all this overhead work, and in their place find bright, clear rooms, with nothing but the lamps overhead, while underneath the presses, on the floor, are nearly 100 motors, ready on the instant to do their appointed work, and under perfect control.

The motors are controlled as follows: Each press motor is provided with two controllers, each made of special cylindrical design for this plant, with crank-handles on top, similar to a street-car controller. One is a series controller, or starting box, used when "making up," or starting slowly, and is never in use for

more than a few seconds at a time, and the resistance in the controller is not designed to carry full current indefinitely. This is used to bring the motor up to about half speed, at which point the resistance is cut out of the circuit. For the regular operation of the press, the particular speed required under the varying conditions is obtained from the second controller, which is a special rheostat in the shunt field; by increasing or decreasing the amount of saturation in the field the speed is varied, and within the limits required for this work there is no more economical method of control. The rotary presses are arranged to give from 35 to 65 impressions per minute, while the top-cylinder presses, on ordinary work, vary from 14 to 20 impressions per minute, as also do the cylinder job presses. The small job presses have a range similar to the rotaries, while the folding machines are run anywhere from two-thirds to full speed. Where a greater range than can be economically obtained by varying the shunt-field strength is desired, compound controllers are used, with resistance in series, with the armature for the lower speeds, and shunt-field controller for the higher. Quarter and half-horse-power motors are Sprague. All others are Westinghouse. The motors installed were as shown in the table on the next page.

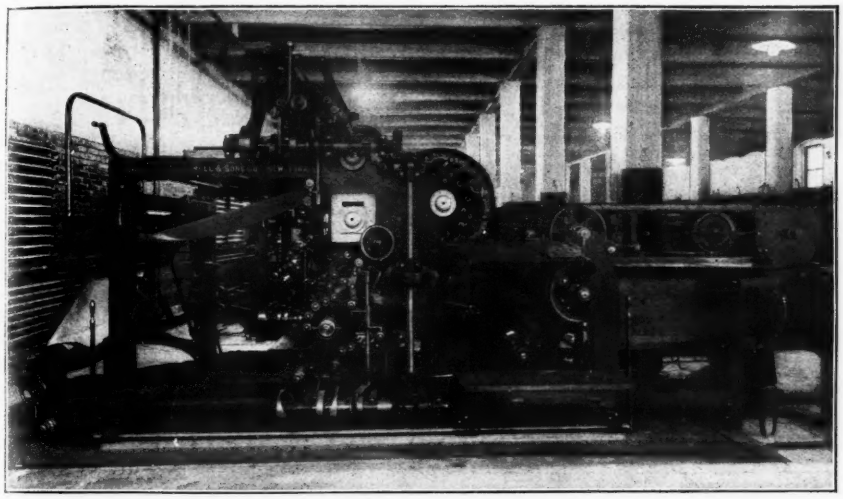


FIG. 7.—ELECTRICALLY DRIVEN ROTARY PRESS.

Particular attention is called to the arrangement of the motors on the machines. They are, in practically every case, located underneath the apparatus, driven in such a position that they take up no floor space and consequently less area is required than with belt-driven machines, since the old tight and loose pulleys, which ordinarily project on one side, are omitted. Yet each motor is perfectly accessible for brush adjustment, oiling or repairs. All of the motors were put in with a considerable margin of power, with the result that they always run cool and require very little attention. The controlling mechanism, consisting of main switch, circuit-breaker and the two controllers, is located at the most convenient place for the operator.

It is almost invariably cheaper to run a private isolated plant to furnish electricity for power and lighting rather than to buy it from the local company. The reason for this is found in the combination of circumstances. If the cost of simply *making* power alone was considered, the central station could, in many cases, show a lower cost at the switchboard than would be found in the private plant. But there are two elements entering into such cases which must be considered. In practically every case it is necessary to heat the plant for a period of six to eight months in the year, and other machinery in the plant requires the presence of an engineer. When the steam is first used for running engines and the buildings are heated with the exhaust steam the expense for coal, above that required for heating only, is very slightly increased, and the labor cost in most small plants remains the same. There remains only the interest and depreciation on the engines, generators and switchboard of the private plant and the repairs thereon. The second point is found in the fact that it costs the central station plant more to *deliver* the power, outside the walls of the power-house, than it does to generate it inside. This, coupled with the heating question, accounts for the large number of private plants in every city. A comparison of the results of the Curtis plant with power from a central station may be interesting. The cost of running the plant for a month was $1,455.33, of which 41.3 per cent is fixed charges (taxes, insurance, interest, depreciation, repairs, etc.). Deducting the heating cost, which averages $211.83 per month throughout the year, this leaves a net cost of $1,244.50. During the month there were delivered to the switchboard 83,400 kilowatt-hours, or 111,510 horse-power-hours, making the net cost of 1.49 cents per kilowatt-hour, or 1.11 cents per horse-power-hour. The lowest price obtainable from the local electric company was four cents per horse-power-hour. This represents, on the basis of above power developed, a saving of $3,222.64 per month, or $38,671.68 per annum. Under these circumstances the economy of the private plant is very evident.

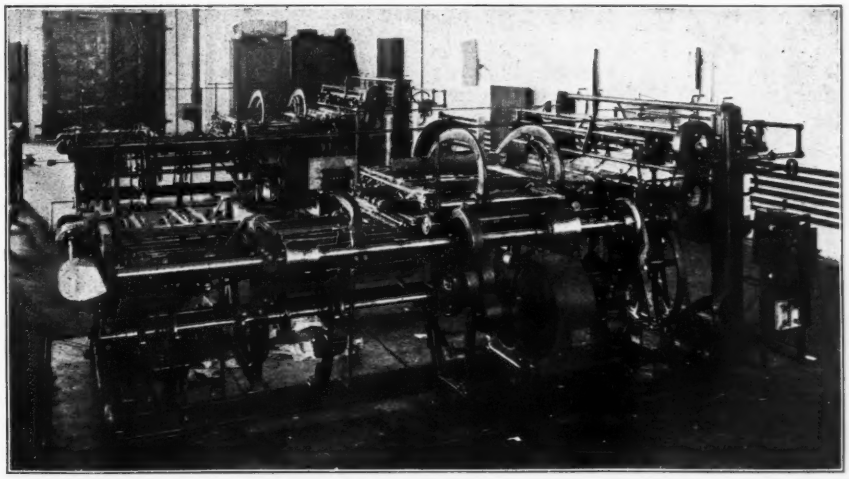


FIG. 8.—FOLDING MACHINE, ELECTRICALLY DRIVEN.

It is stated that the Providence, R. I., Telephone Company will soon increase its capital to $1,000,000 by the issue of $400,000 of new stock offered at par, $50, to stock of record March 29, in the proportion of one share for every three held.

The Bibber-White Company.

Mr. Grosvenor Colkins has been appointed receiver of the Bibber-White Company, electrical supply dealers, of Boston, and will wind up the affairs of the corporation. The Bibber-White Company has been in difficulties for some time past and the creditors have asked for a receivership as the best means to get settlement of their claims. Mr. E. L. Brown, who was treasurer of the corporation, will be associated with the receiver in closing up the affairs of the company. The appointment of Mr. Brown to assist the receiver was made at the instance of the court and it is believed that his connection with the closing of the company's affairs will result beneficially to the creditors.

MOTORS IN THE CURTIS PUBLISHING COMPANY'S PLANT. (See Page 421.)

No.	Horse-power.	Total Horse-power.	Speed.	Machinery Driven.
19	10	190	410— 820	Rotary presses.
21	5	105	500— 750	Flat-bed presses.
5	5	125	500— 750	Cylinder job presses.
3	2	6	500— 825	Small job presses.
1	1	6	500— 825	Small job presses.
3	3	9	800—1,080	Folders.
1	2	2	800—1,080	Folders.
3	2	6	500— 825	Folders.
6	3	18	840— 840	Cutters.
1	2	2	600— 975	Baling machine.
1	½	½	540—1,350	Winding machine.
6	¼	1½	1,000—1,200	Stitching machine.
1	15	15	900— 900	Blocking machine.
1	2	2	1,200—1,200	Typesetting machine.
19	¼	4¾	1,800—1,800	Raising delivery table.
1	2	2	800—1,200	Raising feed-tables, portable.
3	20	60	.....	Elevators.
1	15	15	1,300—1,300	Elevators.
1	7½	7½	500— 850	House pump.
1	15	15	400— 800	House pump.
2	2	4	250— 800	Boiler feed pumps.
1	1	1	250— 800	Boiler feed pumps.
1	2	2	1,700—1,700	Economizer scrapings.
2	8	16	100— 275	Mechanical draft fans.
1	11	11	200— 500	Ventilating fans.

Total motors, 105. Total horse-power, 511¼.

Municipalizing.

A virulent case of municipal ownership has broken out in the Wisconsin Legislature. The Solons of that state have enacted a bill giving any municipality a right to issue negotiable bonds on the petition of a majority of its freeholders for the establishment and maintenance of a telephone system. The bonds are to draw five per cent interest and are to be paid in 20 years, 5 per cent being set aside annually for a sinking fund. With the maturity of the bond the plant is to become the unencumbered property of the township.

It is understood that the legislature will also authorize municipalities to go into the grocery business, the drug business, the plumbing and hardware business, to be their own lawyers, doctors, and undertakers, and possibly will municipalize the churches also. At least, if this is not understood, it is pretty certain to follow, for the one proposition is as ridiculous as the others.

Proposed Dissolution of the New England Electric Vehicle Company.

A special meeting of the stockholders of the New England Electric Vehicle and Transportation Company, of Boston, Mass., will be held in Jersey City, N. J., on April 29, to consider the recommendation of the directors that the company be dissolved. The circular which has been sent out to the stockholders states that there are 223,498 shares of stock outstanding, par $10, fully paid, and 1,674 subscription certificates upon which $5 a share has been paid in.

On March 1 the company had on hand in cash $6,070.84 and 245 vehicles of various types. It also controls the entire capital stock ($100,000) of the Boston Transit Company. For the six months ending with March 1 the gross income, including profits on sales and exclusive of interest on deposits and rentals, amounted to $93,310; total expenses, $211,969. In the circular the directors state that in carrying on a public passenger, carriage and delivery-wagon business in Boston the expenses exceed the receipts in spite of every effort at economy, and, though the reduction in operating expense has been continuous, the board is of the opinion that in view of the large outlay necessary for the establishment of the present business and its limited scope and as the returns which were expected at the beginning will not materialize, they do not feel justified in paying out cash to purchase other vehicles or to expend it for the further continuation of the company, as under existing conditions the return which is to be obtained is not commensurate with the amount of the capital.

The company is said to have no debts other than current liabilities, which include a number of cases pending for personal injuries, but as the company is properly insured it is not believed that the damages in any case will exceed the limit named in the policy. It is said also that the Electric Vehicle Company will agree to a cancellation of the contracts between itself and the insurance company.

The Chicago Automobile Exhibition.

The automobile exhibition, in the Coliseum, Chicago, Ill., was opened officially on March 23, and, although the exhibits were not complete because of bad weather the Saturday before, the attendance was good and many interesting exhibits of both automobiles and accessories were shown. The machines shown by the Woods Motor Vehicle Company included a handsomely finished landau and a brougham of attractive design, besides several hansoms and lighter vehicles. The Electric Vehicle Company and the National Automobile and Electric Company also had handsome exhibits, the feature of the latter company's product being its controller, the contact-making devices of which approach closely to the lines of an ordinary knife switch as in contrast with the cylinder, carrying contact strips engaging with flexible spring fingers, ordinarily used.

Of the steam and gasoline machines shown the steam racer of the Milwaukee Automobile Company was prominent. This vehicle is said to have a record of half a mile in 27 seconds and was sent around the circular track, which had been built in the centre of the auditorium, to show its speed ability. Vehicles of every description, from gasoline bicycles to electric omnibuses, were in evidence on the track for demonstration purposes and the exhaust of the gasoline engines was much less offensive than it was the year before.

The Fanning Manufacturing Company, of Chicago, had on exhibition its Fanning electric automobile, in which is used the Porter battery.

The American Roller Bearing Company was represented by a number of gentlemen from the company's office in Cleveland, Ohio.

The Shelby Steel Tube Company, Shelby, Ohio, exhibited samples of steel tubing, etc., and occupied a prominent place among the exhibits.

Among other exhibits were those of the Turner Brass Works, of Chicago; Munger Vehicle Tire Company; Moffett Roller Bearing Company; Standard Welding Company, of Cleveland, Ohio, and the Diamond Rubber Company, Akron, Ohio.

Mr. Clinton E. Woods, of Woods, Waring & Company, Chicago, was a prominent figure at the Automobile Show, and, although his company had no exhibit at the show, its catalogues were much sought after. Mr. Woods was a pioneer in the automobile field.

The Electric Vehicle Company, New York, had an exhibit consisting of a Columbia cabriolet, a surrey and a Mark 12 runabout. The company was the recipient of a number of orders. The company was represented by Messrs. M. J. Budlong and F. G. Russell.

The Woods Motor Vehicle Company, of Chicago, occupied a prominent position at the exposition and showed various styles of vehicles, including a light road wagon, trap, brake, stanhope, hansom cab, landau and wagonette. The company was well pleased with the exhibition and says it has made a number of sales as a result.

The National Automobile and Electric Company, of Indianapolis, Ind., of which Mr. L. S. Dow is president, showed several styles of electric runabouts, brakes and delivery wagons, and had a very attractively arranged exhibit. The Hewitt-Lindstrom Motor Company, of Chicago, showed an electric automobile omnibus, its record-breaking runabout and several styles of brakes and carriages.

THE SECTIONAL THIRD-RAIL ELECTRIC SYSTEM ON THE BALTIMORE & OHIO RAILROAD.

BY HENRY HALE.

What is known as the Baltimore & Ohio Belt Railroad, extending through the city of Baltimore, Md., from the southwestern to the northeastern suburbs, has been prominent since it was constructed in connection with electrical engineering problems. The railroad itself, which is a double-track line seven miles in extent, was planned to avoid the transfer of passenger and freight cars across Baltimore Harbor, necessitating considerable delay in general train service. A portion of the route, for about two miles, is under the business section of the city, and the Belt Line, as it is termed, includes one of the widest and highest tunnels in the world. Eastbound trains encounter a combination of grades and curves, unavoidable in the construction of the road, which requires considerable traction power—enough to overcome what would be practically a one per cent grade on a straight line.

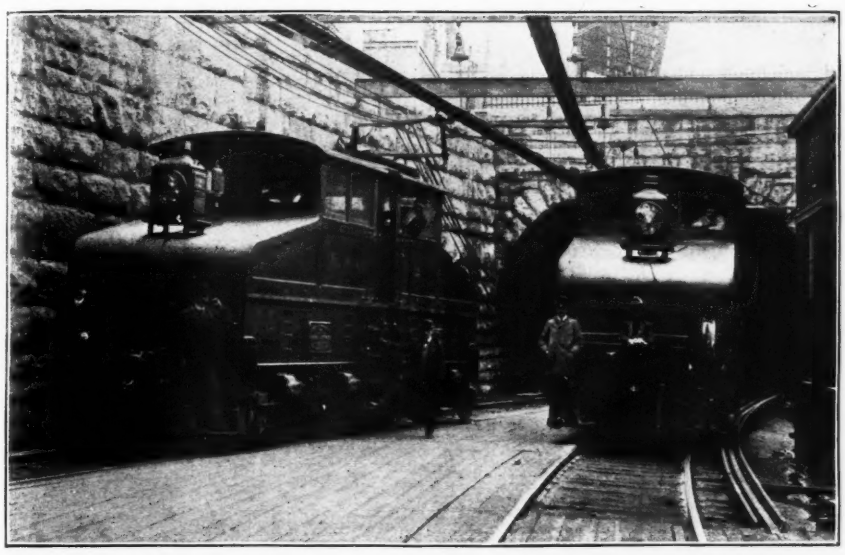


FIG. 1.—ELECTRIC LOCOMOTIVES ON THE BALTIMORE & OHIO BELT ROAD.

Since the Belt Line was opened for operation, electric locomotives have been used to haul freight trains through the tunnel section and to the summit of the eastbound grade. The electric current was conveyed from the power-house by what is known as the overhead conduit system, the motors taking current by means of a flexible bar connected to a metallic shoe which slides in what may be called the current trough. The locomotives weigh 96 tons each and are equipped with four General Electric motors, mounted directly upon the axles. The motors develop 300 horse-power each, giving them the ability to pull from 2,000 to 2,500 tons through the tunnels and approaches without difficulty. This method of supplying current, however, has been open to criticism, as more or less leakage has occurred in spite of the insulation. This was one of the reasons why the railroad company determined to substitute what is known as the sectional third-rail system upon the Belt division. It is understood that electric traction has also been considered as a substitute for steam power upon portions of the road in the mountainous sections of Maryland and West Virginia, and the equipment of the Belt Line has been in the nature of an experiment to determine if the third rail and sectional third rail could be adopted elsewhere.

In the installations of the new systems the motors, which have been taking the overhead circuit, were used, as but a few alterations were required—merely the attachment of cast-iron shoes to the exterior of each driving-wheel truck. The windings of the electric motor used to operate the air compressor were changed to permit the motors to operate as motors or generators, while two valves were added to the compressor for operating the air-brakes, in order to work either as a compressor or as an engine.

The rails are charged in the following manner: The motorman on the electric locomotive turns the controller to the first notch, opening the throttle to the air engine, which, taking compressed air from the storage reservoir of the air-brake system, drives an electric generator which generates sufficient current to operate the magnetic switch and connect the third rail with the current supply from the power-house. At the instant the magnetic switch is closed the power-house current passes through it to the third rail, thence through the contact shoe and the controller to the electric generator which operated the switch, and also the four motors of the electric locomotive. Immediately and automatically the generator becomes a motor, operated by current from the power-house, and drives the air engine as an air compressor, recharging the compressed-air reservoir from which the air engine originally obtained its power.

At no time is it possible during the operation of this system to have a charged conductor or third rail except when the motorman has turned the controller, and then only one section is charged; *i. e.*, the section on which the electric locomotive is operating. The section is "dead" while the locomotive is standing.

Both the third rail and the sectional third rail were placed in position on the Belt Line under the direction of Mr. John M. Murphy, inventor of this variety of the sectional system. They were completed in time to be tested during a snow-storm, when one of the motors pulled a train consisting of a steam locomotive and 22 loaded coal cars, representing about 1,400 tons dead weight, over the line without difficulty. The current rail, as well as the truck itself, was covered with snow and ice, but apparently no difficulty was encountered in maintaining the electric connection. When the motors have been operated both with and without trains, tests have been made to ascertain if any portion of the sectional system was charged except that directly under the motor. But the action of the switches appear to be perfect in this respect. They are of the automatic magnetic type, receiving current from a copper cable of 1,000,000 circular mils section. A cable of the same size is carried in a vitrified conduit filled with insulating compound to that section of the third-rail conductor controlled by the switch. The magnetic switches have a capacity of 2,000 amperes each, and are enclosed in cast-iron, weather-proof boxes. The switch is practically a solenoid with two windings; one a fine winding, with many turns around the magnet, taking a current of about 550 volts from the generator on the electric locomotive through the controller, the contact shoes and the third rail. This current raises a plunger, which closes the switch and feeds the power-house current of 700 volts to the third rail. The moment the weaker generator current passes through the fine winding and closes the switch, current from the power-house passes through the heavy winding of the

magnet and keeps the switch closed until the contact shoes of the electric locomotive have passed to the next section. The circuits around the magnet being broken, the switch opens by gravity. The contacts last to operate are of carbon, and the spark, if any, is between these contacts, thus preventing the metallic contacts from injury. At the instant the contact shoe at the forward end of the locomotive comes in contact with the forward section of the third-rail conductor, the switch controlling the feeder for that section closes, and the switch for the rear section opens.

Each of the magnetic switches is provided with a single-pole, double-throw knife switch in series with the fine winding of the magnet. This is used by the inspector to test the magnetic switch and ascertain whether it is in proper adjustment. Should it be necessary to make any adjustment while the section controlled by the switch is in use, the current is fed to that section by means of a temporary bridge which he places in position.

As will be noted in the illustrations, the current rails are fully as heavy as those used in the construction of the track, weighing from 80 to 90 pounds to the yard. They are laid at a distance of 24 inches outside of the track and divided into sections of about 500 feet in length. The ends of the rails are inclined so that the contact shoes of the locomotives may glide from one to the other without difficulty. The shoe is held, however, by a flexible attachment which automatically keeps it in position where the rail may be depressed.

The overhead construction remains as shown in the photographs, and the electric locomotives are adjusted to receive current from above or below at the will of the operator. The archway and conductor, however, will be removed as soon as the arrangements are completed for operating the entire Belt Line with the new method.

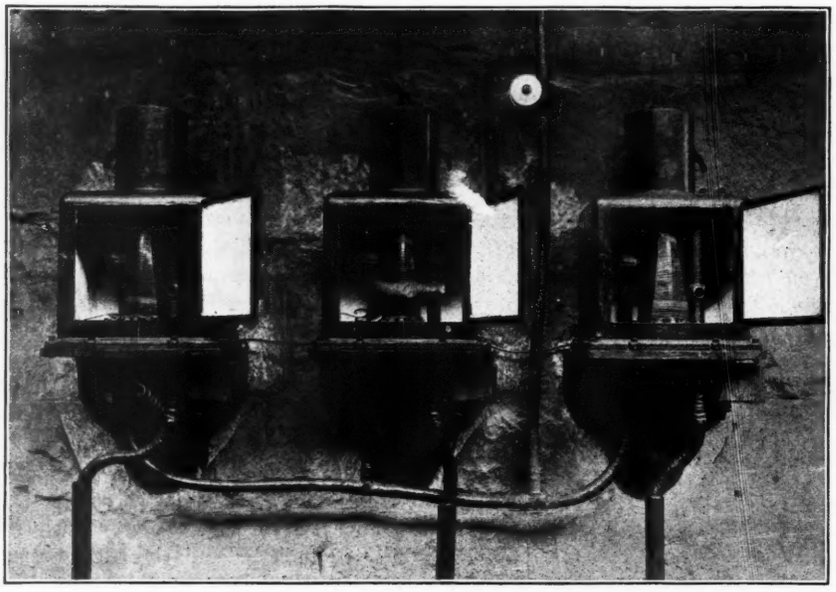


FIG. 2.—PROTECTED SWITCHES ON BALTIMORE & OHIO BELT ROAD.

FIG. 3.—OVERHEAD CONSTRUCTION, BALTIMORE & OHIO BELT ROAD.

McGill University, Montreal, Canada, has recently installed two electric furnaces in its chemistry department, which are large enough to take off a current of 100 amperes. A heat of 3,000 to 4,000 degrees centigrade can be obtained from them.

New York Electrical Society.

At the 213th regular meeting of the New York Electrical Society, held in the new station at Eighth avenue and Forty-ninth street, New York city, of the New York Electric Vehicle and Transportation Company, Mr. G. Herbert Condict, the company's electrical engineer, made the speech of the evening, his subject being the work that his company had done and is doing. Mr. Condict dealt with his subject in a comprehensive manner, and stated, among other things, that the company is now operating some 300 vehicles, the company's present quarters having a capacity of 500 to 700. Extensions and improvements are planned, and Mr. Condict expects that the company will soon have a branch in Brooklyn where it will extensively advertise funeral hearses and automobile baby coaches.

The automobile situation in New York is considered by the company to be very encouraging, as figures show that there are 400 electromobiles in use in the city at the present time, as against 400,000 horse-drawn vehicles. The next meeting of the society will be held at Columbia University, Washington Heights, New York, on April 25, at 8 P. M., the lecturer being Mr. Charles F. Scott, of the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa. The paper to be read is entitled "Alternating-Current Motors." It will be illustrated by experiments and apparatus. Three new members were elected, their names being Messrs. E. H. Mullin, J. Lloyd Wayne and Franklin S. Holmes, all of New York city.

THE CONSTRUCTION OF SMALL TELEPHONE EXCHANGES—VI.

BY A. E. DOBBS.

HANGING THE CABLE.

In a small exchange where there is not more than, say, 50,000 feet of cable to be hung up, the expense will not justify special appliances for the handling of it, and, therefore, the best way to handle the reel is to mount it on a long, iron shaft, two inches in diameter, which is lifted from the ground by means of jack-screws; then, as the slats from the outside of the reel are removed, care should be taken to remove all screws or nails from the inside of the reel that can possibly snag or mar the lead sheath of the cable, for this is very important.

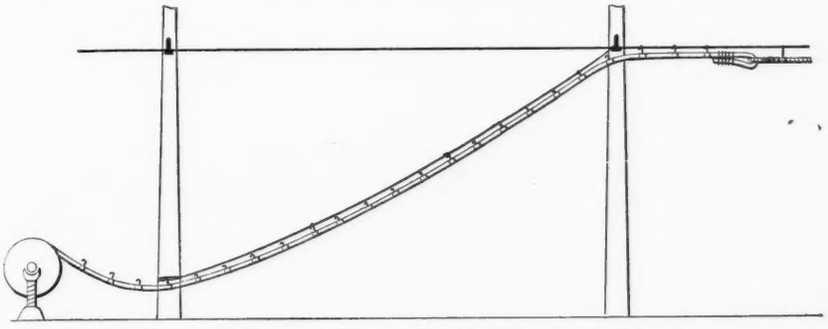


FIG. 15.—METHOD OF RAISING AND STRETCHING THE CABLE.

From the cable reel, which should be placed a little more than one pole section back from the terminal pole, a No. 6 steel wire is carried up as far as the messenger wire to act as a carrier wire in raising the cable up to the pole (Fig. 15). The cable hangers, which should be put on as the cable leaves the reel, should be spaced about 20 inches apart and require the services of one or two men, according to the speed at which the cable is being pulled, which will generally be found to be at the rate of about from 12 to 18 feet per minute.

An inch rope is required to pull the cable and, if the pull is not a very long one, say, 500 feet, it might be attached to a set of 10-inch blocks and pulled out by means of a horse attached to the end, or, where this is not practicable, it can be attached to a capstan or windlass. In large installations a windlass mounted on a small traction engine has sometimes been used for this purpose.

When the cable is running out there will, therefore, be three men needed at the reel; one to turn the reel over and look out for accidents, and who should also be instructed to look sharply for cuts, scratches or holes in the cable sheath. The other two men will be needed to put on hangers and assist in watching the cable. Upon observing the slightest defect in the lead sheath the cable should be stopped until the defect can be examined, and if it should prove to be a puncture it should be either cut off or repaired right there; though, in order not to keep the gang of men idle, a simple puncture might be stopped up with wax and plainly marked, so that the splicers can afterwards find and repair it after it is up.

THINGS TO REMEMBER.

In estimating the amount of cable needed, it is well to remember that there should be an allowance of five feet at each end, at the least, for the loop into the box or terminal, and as it is likely that at least two feet of one end of it will have to be thrown away altogether, it might as well be estimated at seven or eight feet at each end.

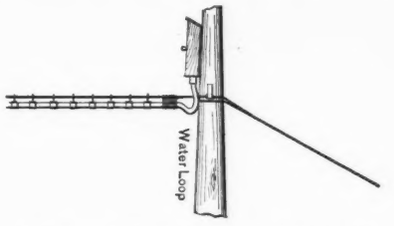


FIG. 16.—CONNECTING TO A TERMINAL.

Another thing should not be forgotten when the terminal is put on; the water-loop, so called, in the cable, which, up to the terminal, is filled with hot paraffin, or asphalt, to expel all moisture and prevent more from getting in (Fig. 16), the paraffin should always be poured into the terminal or pot-head boiling hot, to insure its going to the proper place and also to expel any moisture that may have gathered in the end of the cable when opened. If the paraffin is not hot enough it may not go as far down into the cable as intended, with the result that as hot weather comes on it will melt near the cable sheath while the centre remains comparatively solid, and thus add its weight to the wires which in some cases, at least, may cause trouble from open circuits that has in the past been attributed to this cause.

STRAIGHTENING UP THE CABLE.

After the cable has been hung up, the end next to the reel, at least, will be anything but straight and smooth; in fact, it will more than likely look like that shown in Fig. 17, and the next step to take is to straighten it out.

First, fasten securely with marlin twine the end farthest from the reel that has been pulled through, and the terminal-head might be connected in, so that there is no uncertainty as to the amount of cable needed at that end. This end, owing to the strain put upon it in pulling through, will be reasonably straight and will, in consequence, need very little work, but some of the hangers will be spaced unequally and there will be some bends in the cable that will need attention, so the cable man procures a block of wood, with a groove cut in it that fits the cable fairly well, to use in tapping it in order to straighten out the bends—for the cable should never be struck directly with a hammer or other hard substance—and a cable seat similar to that shown in Fig. 19, which is simply a seat suspended from two grooved wheels, which may be pulled along by a rope either by a man on the ground, or a man on the next pole, or the rider himself can pull it along with his hands. The helper on the next pole should also have a set of blocks with which he can pull the slack out of the cable as the man on the seat straightens it out by tapping the wooden block with a hammer.

This is followed up from section to section till the cable, instead of looking like

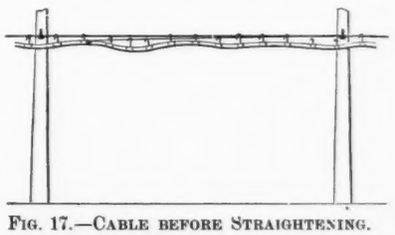


FIG. 17.—CABLE BEFORE STRAIGHTENING.

that in Fig. 17, will present an appearance like that in Fig. 18.

CABLE SPLICES.

If there are more than 200 or 300 feet of cable to put up it would be well to secure the services of some man who understands cable work, for this is not a job to be entrusted to an amateur, but as men in search of work sometimes represent themselves to be qualified to fill positions that they are not, it might be well to illustrate some of the most approved

methods in use among cable men of long experience.

In the first place, it has not been the custom in the past to solder cable splices as the resistance of a soft copper joint when not exposed to the air is not worth taking into consideration, but with the advent of common battery systems it is becoming quite a question as to whether it pays to neglect soldering, for joints that would never make trouble in years in the magneto, or self-contained system, will often break down completely under the continual stress and light leakage of a battery continually present in the wires. These systems require the most careful construction, including soldered joints, and the most careful insulation to maintain their efficiency.

But soldered cable joints bring up another difficulty; acids can not be used, for if there should be left a slight amount of dampness in the splice—and acid is damp of itself—they will combine with the paraffin and not only destroy the copper, but break down the insulation. If rosin is used, there is danger that the men may be in a hurry some day and forget to see that the solder is thoroughly sweated in, in which case the rosin may form a coating around the wire and make an open circuit.

Then, again, if the solder is not "sweated in," as, when it is applied too cold, it will leave lumps on the end of the wire which will make it difficult to slip the paper sleeves into place, to say nothing of their liability to punch through the insulation.

If left to the writer to decide he would say this: *If a central battery plant is contemplated, solder every connection, see that the work is entrusted to men who can be depended upon never to slight their work, and instruct them to see that the solder leaves no lumps and that it makes a perfect contact.*

In putting in a magneto system do not bother with solder; not in cable joints, anyhow.

The first thing to keep in mind when opening a cable to make a splice, or for any other purpose, is, that a paper core should not be exposed to dampness—for even air, supposed to be dry, contains some moisture—any longer than is absolutely necessary and a cable should not be opened late in the afternoon unless sure that the splice can be completed the same afternoon or evening, and never in moist or muggy weather if it can be done at any other time.

First: Bring the two ends together till they pass each other about a foot, for the chances are that some of the ends of the wires will have to be thrown away.

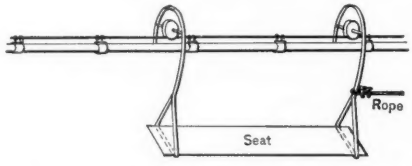


FIG. 19.—CABLE SEAT HUNG ON CARRIER WIRE.

Next: Procure a piece of lead pipe two feet in length, large enough to slip over the cable and slide it back on the cable out of the way.

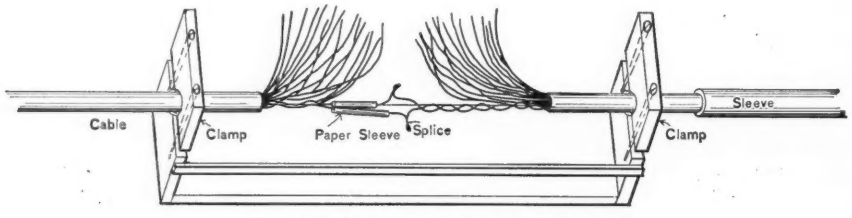


FIG. 20.—MAKING A SPLICE IN CABLES.

Next: Make a box about two feet long, similar to that shown in Fig. 20, with clamps for holding the cable in place while the splice is being made.

Next: Strip off the lead till the two ends are about 18 or 20 inches apart and fan out the ends.

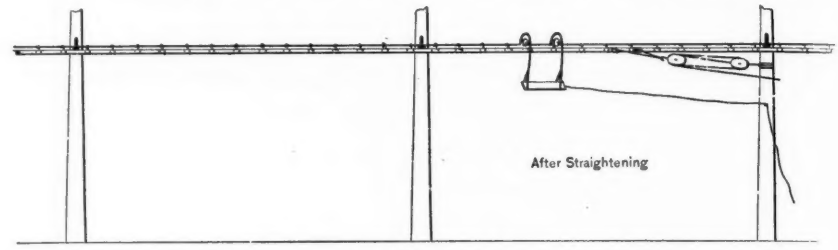


FIG. 18.—CABLE FULLY STRAIGHTENED.

and as the ends are fanned out these should be slipped on over the conductors. It is also a good plan to boil out these sleeves in paraffin before putting them on.

Now proceed to splice the conductors by twisting the two ends together, *always keeping wires of the same color together,* for crossed colors may be a considerable source of annoyance if this is neglected.

Also keep the same pairs together.

These splices should be distributed along the space between the two ends of the lead sheath in order to avoid bunching and other troubles as well.

As each splice is finished, turn the ends back and slip the paper sleeve into place and press the pair together, as shown in Fig. 21.

Proceed in this manner till all the conductors are joined, when they are all laid together and boiled out with hot paraffin, as in Fig. 22, till all the bubbles are boiled out.

The whole is then wrapped in thin cheesecloth and again poured over with hot paraffin till all air bubbles cease to arise, when the lead sleeve is slipped into its place and the ends beaten down and finished with a plumber's wiped joint, as in Fig. 23.

While there are some linemen who can make a wiped joint, it is generally advisable to get a first-class plumber to do this work—if he can be obtained—as a very slight defect, as an air hole no larger than a pin, will make all kinds of trouble in a very short time.

There is still another splice, known as the T or Y-splice, which is sometimes used in branch cables, which is shown in detail in Figs. 24 and 26.

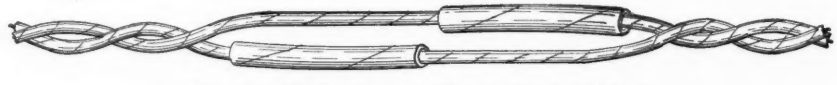


FIG. 21.—FINISHED SPLICE WITH SLEEVES IN PLACE.

It will now be noticed, if not known before, that the wires are all twisted in pairs and that one wire of each pair is red and the other white, or the combination is sometimes blue and red. Previous to this there should be made ready a lot of paper sleeves about two inches in length,

There is still another branch splice, shown theoretically in Fig. 25, in which part or all of the cable is cut and the ends brought up into the terminal, where they may be connected together across the terminal head or left open as desired. The finished splices in both loop and Y-con-

nections are the same as that shown in Fig. 26.

THINGS WORTH KNOWING.

If the cable splicer should find that his hands perspire too much for handling the paper-covered conductors, he can obtain dry hands by washing them in alum water. In countries where the weather is extremely hot, a mixture of paraffin and beeswax, in about equal proportions, will make a harder mixture and prove more satisfactory than paraffin alone.

There are also asphaltum or tar compounds, sold under various names, which make very satisfactory insulating materials. In fact, many people think they are better than paraffin. They are sold in various grades of hardness.

When wiping a joint on a lead sleeve, use what is known as half-and-half solder, and use a tallow candle as a flux.

Before pouring paraffin over the splice it is well to warm up both ends of the lead sheath with a blow torch, beginning about two feet back and working toward the splice in order to drive any moisture there may be to the end.

Do not forget that lead cables require careful handling, nor let the men forget it.

Southwestern Gas, Electrical and Street Railway Association.

The annual meeting of the Southwestern Gas, Electrical and Street Railway Association will be held in Houston, Tex., on April 19, 20, 21 and 22. The meetings of this association are justly regarded as the most important gatherings of the electrical fraternity in the Southwest, and it is expected that the attendance this year will be large. A number of interesting papers have been prepared for presentation before the meeting and these will be discussed by the members present. As usual, a number of attractive entertainments have been arranged by the local committee at Houston, and all who attend the meeting expect to have a good time as well as an instructive session in comparing notes of progress and development.

German Electric Railway Statistics.

It appears from the annual statistics of electric railways published in the *Elektrotechnische Zeitschrift,* that at the end of the past year there were in operation in Germany about 1,900 miles of electric railways, having a total length of track of 2,800 miles, as compared with 1,430 miles and 1,980 miles, respectively, for the previous year. The rest of the figures given take us only up to September 1, 1900, when the aggregate output of the generators installed for working 2,660 miles of track amounted to 75,608 kilowatts, as compared with 52,509 kilowatts for 1,760 miles of track in the previous year, or an increase of 44 per cent. On the other hand, the buffer and station batteries installed up to the same date show an increase of only about 25 per cent, as against 164 per cent for the previous year, the total capacity of the accumulators amounting to 16,890, compared with 13,532 kilowatts on September 1, 1899. Adding the output of the generators and accumulators, respectively, together, it will be seen that there is a total available output, for working the lines, of 92,498 kilowatts. According to statistics published last year relative to central electric lighting stations in Germany, there was installed in the same on March 1, 1900, an equivalent of 191,646 kilowatts in generators and 38,412 kilowatts in accumulators; together, 230,058 kilowatts, so that on September 1, 1900, the total output of the generators and accumulators installed in German lighting and power stations amounted to 322,550 kilowatts in round figures, or, approximately, the equivalent of 440,000 horse-power, which represents an increase of about 38 per cent as compared with the figures for the previous year, says a British contemporary. A valuable feature of the statistics consists in that for all those lines supplied with current from independent generating stations, the number of kilowatts provided per mile of single track or per motor car is computed. For 70 lines enumerated as belonging to this class the average number of kilowatts provided per mile of track is shown to be 31.8, as compared with 32.8 in 1899 and 33.0 in 1898, while the average number of kilowatts per motor car is given at 15.1 as against 14.3 and 14.2 in the years 1899 and 1898, respectively. Extreme cases have not been taken into account in making these computations. As regards systems, the overhead trolley still remains supreme. Up to date but three short stretches of line, totalling a length of not more than two and one-quarter miles, are worked in Germany on the conduit system. Accumulator traction pure and simple is also in operation in only three cases, though it is noteworthy that this system has been adopted on two Bavarian full-gauge lines having lengths of over 31 and 37 miles, respectively. In conclusion, it may be observed that the third-rail system has been adopted hitherto, so far as Germany is concerned, only in the case of the Wannsee railway, which has already been fully described.

FIG. 22.—PARAFFINING A SPLICE.

FIG. 23.—COMPLETED SPLICE.

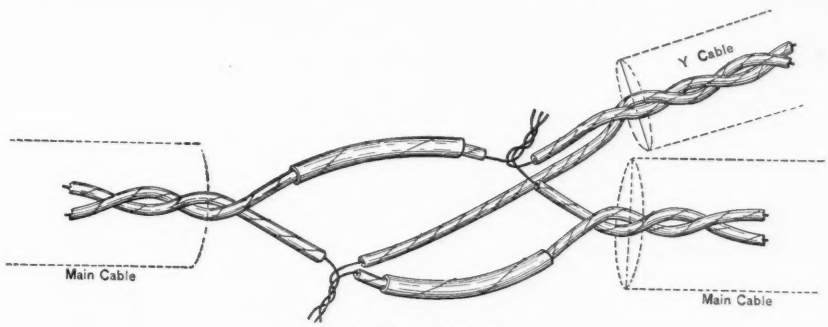


FIG. 24.—Y-SPLICE.

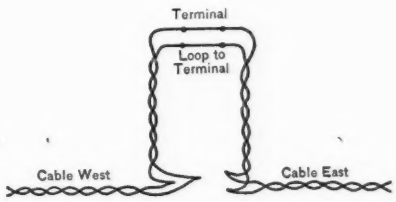


FIG. 25.—DIAGRAM OF LOOP SPLICE.

FIG. 26.—Y-SPLICE COMPLETE.

Receiver for the Anchor Electric Company, of Boston.

James E. Leach has been appointed receiver of the Anchor Electric Company, Boston. This appointment was made upon the application of counsel for Norman Marshall and Guilford M. Stuart, who allege mismanagement of the affairs of the company by the defendants.

SYSTEMS OF ELECTRIC TRANSMISSION AND DISTRIBUTION—I.*

BY CHARLES P. STEINMETZ.

INTRODUCTORY.

The motor question is the greatest difficulty met in changing from an alternating to a continuous-current system. Motors built to suit both types of currents are not good for either, due to the great differences in the inherent nature of the two motor types. The preferable arrangement, obviously, is immediately to install the final system of distribution. This, however, can be done by continuous current only where a concentrated demand can be foreseen in the near future, which in most instances is not the case, but, on the contrary, in many places the demand never increases so as to permit to change to continuous current, while in many cities which were supplied by alternating current exclusively for many years, a continuous-current central distribution is being installed.

Therefore, the only way appears to me to replace the alternating motors by continuous-current motors and use the former again in further outlying territory which is being developed by alternating current.

Fortunately, the demand for light appears mostly before that for power, and the motor load in the outlying districts which are on the alternating system, is usually quite moderate, some types, as elevator motors, being hardly used at all, so that the motor question is generally not as serious as appears at first.

Regarding the European practice with converters, I can answer by stating that the converter has not been used to any extent, partly due to the universal use of the rather high frequency of 50 cycles, mostly, however, due to the almost entire ignorance of European engineers regarding this apparatus. Now the converter is very rapidly being introduced in Europe, though still mostly by American firms and their affiliated European companies.

The variation of speed of continuous-current shunt motors by varying the impressed voltage finds its analogy in the variation of speed of the induction motor by varying the impressed frequency. Either requires, however, two supply circuits, and the latter is, therefore, as far as I know, not used, since, by changing the number of poles of the induction motor, a change of speed can be secured with one supply circuit, while this is not well feasible with continuous-current motors. Field control of speed, however, as possible within a limited range with continuous-current shunt motors, is not feasible in induction motors.

When reducing the speed and frequency of the induction motor, some losses, as the I^2R, remain the same; others, as hysteresis and friction, decrease in the same way as in the continuous-current shunt motor, and since the output decreases with the speed, the efficiency is somewhat lower at lower speeds. Since, however, the hysteresis losses, which decrease with the speed, are a greater percentage in the induction motor than in the shunt motor, as a rule the efficiency of the induction motor holds up somewhat better at lower speed than that of the continuous-current shunt motor.

I.

Historically, the first electric machines used for commercial service were constant-current alternators for series arc lighting by Jablochkoff candles. This was in the 70's, before the times of the arc and incandescent lamp. The development of the arc lamp introduced the continuous-current system, since the early arc lamps could be operated only on continuous current, in series on a constant-current circuit. Soon after this the invention of a commercially successful incandescent lamp introduced the constant-potential, continuous-current system. Thus a competition started between the constant-potential system operating incandescent lamps in multiple on a two or three-wire system, and the constant-current system operating arc lamps in series. Soon both types of lighting found their proper fields of application, the incandescent lamp for indoor illumination, the arc lamp for street lighting, and, in general, large units of light.

The alternating-current system, however, had entirely disappeared and the alternating-current machine seemed of historical interest only, until in the middle of the 80's the development of the alternating-current transformer reintroduced the alternating-current system, this time, however, as constant-potential system for incandescent lighting. Then a fierce rivalry started between the continuous and the alternating-current system. The alternating system offered the advantage of being able to supply by high-potential feeders and step-down transformers current to distances which could not be reached by the low-tension, continuous-current system, and thus found an extensive introduction in smaller cities and suburbs, in which places the continuous-current system could not compete. The continuous-current system, however, pointed to its ability to operate motors and arc lamps, while the alternating-current system could supply incandescent lighting only.

The alternating-current arc lamp, very unsatisfactory in the beginning, was gradually, though very slowly, improved, until now it is about equal to the continuous-current arc lamp, inferior in some features, as efficiency; superior in other features, as distribution of illumination.

The introduction of polyphase systems and the development of the induction motor between 1886 and 1894 overcame the most serious objection to the alternating-current system by offering a motor equal in its characteristic features to the continuous-current shunt motor, but superior thereto in many points, as absence of commutator and reliability of operation. But still no alternating-current motor existed, nor exists even to-day, which has the characteristic features of the continuous-current series motor—that is, practically unlimited starting torque and a speed varying in inverse proportion to the load, and about the same time where the development of the polyphase induction motor enabled the alternating-current system to operate constant-speed motors, the enormous development of electric railroading offered a field for variable-speed motors of great starting torque, which could be filled only by the continuous-current series motor. Soon afterward the successful introduction of long-distance transmission became possible only by the use of alternating current, so that the relative position of the two rival systems remained essentially the same.

This rivalry between the continuous and the alternating-current system was finally swept away by the successful development of the converter and inverted converter, as apparatus changing from alternating to continuous current and inversely, and it became possible thereby to use in the same system both forms of electric power, by converting them into each other, and applying each system to the use for which it was best adapted. The result is that at the present most large systems use alternating as well as continuous current, the generation and transmission being, as a rule, alternating, the distribution and utilization either entirely continuous current, as in railroading, or partly continuous, partly alternating current.

* A lecture delivered before the New York Electrical Society, November 16, 1900.

II.

More fully to appreciate the relative advantages of the alternating and the continuous-current systems, the characteristic features of the two forms of electric energy must be considered.

The characteristic feature of the alternating-current system is its practically unlimited transformability by stationary apparatus of absolute reliability, which permits, in transmission lines, etc., the use of voltages far beyond those which can be generated directly by revolving machinery, and permits transforming down at the receiving end to low voltage suitable for lighting and other applications, so that, by alternating current, electric power can be transmitted to theoretically unlimited distances; that is, the distance of transmission is limited only by economical considerations.

Continuous current, however, can not be transformed except by motor-generators, which are limited to the maximum voltage which can be used in generators or motors. Continuous-current machines in large constant-potential units can conveniently be built for voltages up to 600 or 700, but when exceeding these voltages the difficulties rapidly increase and an absolute limit is reached, probably not very much beyond 1,000 volts; that is, at voltages far below those which can be considered for power transmission. This limit of voltage is due to the commutator; this does not exist in the alternating-current machines, but the latter can be built to produce or utilize direct voltages of 10,000 to 15,000, while still higher voltages are available by transformation.

Continuous-current arc light generators have been built for voltages up to and beyond 10,000, but these voltages are feasible only in constant-current machines of limited power. Even at 10,000 volts and 10 amperes, the output of the machine is only 100 kilowatts, and thus such machines do not come in consideration for power transmission.

Some smaller power transmission lines have been installed abroad by using a number of continuous-current generators in series, insulated from each other and from the ground, and operating therefrom a number of motors connected in series and in the same way insulated, the machines being of the constant-current or limited-power type. But it is hardly probable that any engineer familiar with modern work would nowadays consider such a system seriously.

Continuous current has to be used at the voltage at which it is generated; thus for power distribution to motors 500 volts, and for lighting by the use of three-wire systems 250 volts can not be much exceeded, which means that the distance to which continuous current can be supplied is greatly limited.

The characteristic feature of the continuous-current system is that the drop of voltage in conductors depends upon the length and cross-section and material of the conductor only; that is, upon its ohmic resistance, while in an alternating-current circuit it depends also upon the shape of the conductor, upon the medium surrounding the conductor, its distance from the return conductor, etc. That is, besides the ohmic drop (equal to resistance times current) in an alternating-current circuit, power may be lost by induced currents, hysteresis in iron, etc., and voltage consumed by self-induction. These effects, as the voltage consumed by self-induction in an alternating-current circuit, are proportional to the current, and since, with the same power transmitted, the current is in inverse propor ion to the voltage, the voltage of self-induction decreases with increase of the transmission voltage absolutely, and in still higher degree relatively to the voltage of the system. While, therefore, it is insignificant, or, at least, easily controlled with the moderate currents and high voltages used in alternating-current transmission and distribution, it becomes formidable when trying to control very large low-voltage alternating currents. It becomes practically impossible in an alternating system to handle economically such very large low-voltage currents of many thousand amperes as are generated and distributed by the larger Edison continuous-current stations, and even with moderate low-voltage alternating currents, as used in an extensive secondary distribution, the problem of installation is very much more difficult and far greater skill is required with alternating than with continuous current, and many methods of construction feasible with continuous current are not permissible with alternating currents, as armored single conductors, etc., so that for low-voltage generation and distribution in large units the continuous-current system is either necessary or decidedly preferable.

III.

Mechanical power can be supplied by the alternating as well as by the continuous-current system, but the different types of motors have different characteristics, thus making the one more suitable for some applications, the other for other applications.

Two types of continuous-current motors exist, the shunt motor and the series motor. The shunt motor is essentially a constant-speed motor; that is, at the same impressed voltage it runs at practically the same speed, irrespective of the load, slowing down only slightly with increase of load. To decrease the speed of the shunt motor a part of the voltage has therefore to be consumed by a rheostat in the armature, so that at reduced speed and in starting the shunt motor requires for a given torque the same power input from constant-potential mains as while running at full speed, and is thus inefficient at reduced speed and in starting. Efficiently the speed of a shunt motor can be varied only by varying the impressed voltage of the armature, which means several supply circuits to the motor, or by varying the field excitation—an increase of field excitation reducing, and a decrease increasing, the speed—which can be done, however, within a limited range only.

The continuous-current series motor is a variable speed motor. Its speed increases with a decrease of load, and decreases with an increase of load, so that at constant-potential supply the torque per ampere input increases with the increase of load, or decrease of speed, and the series motor is uniformly efficient over a wide range of speed, thus being greatly superior in efficiency to the shunt motor in starting and at low speeds. Where frequent starting and acceleration are required, and great starting torque, as in railway work, the shunt motor could not compete in efficiency with the series motor, even if the limited speed of the former were not objectionable.

Where constant speed is required, the shunt motor is used, while the series motor is used for available speed work with very frequent starting and acceleration, as railroading. Combinations of both, as shunt motors with cumulative series fields, are used in elevator work, etc., to combine high efficiency in starting and acceleration with limited speed when running light.

All alternating-current motors are essentially synchronous motors and thus constant-speed motors. The so-called synchronous motor can run only in perfect step with the generator; that is, its armature moves over one field pole every time the generator armature moves over one field pole. Its speed is thus absolutely constant and independent of the load, but it has no torque at any other speed. In self-starting polyphase synchronous motors in starting and during acceleration the field is open-circuited, the motor working as induction motor. The alternating synchronous motor has no analogy among the continuous-current motors, and combines with its motor features many generator features. That is, by varying its field excitation it can be used to vary and control the voltage in the alternating circuit connected to its terminals, just as a generator. It has as high an efficiency as the alternating-current generator, or even a higher efficiency machine can be built to operate directly on very high voltages, 10,000 or more, and is specially suited for large units of power when no great starting torque and frequent starting are required.

BENJAMIN FRANKLIN'S CONTRIBUTIONS TO ELECTRICAL SCIENCE—II.

BY EDWIN F. NORTHRUP.

Franklin's explanation of the action of points in general in discharging electrified bodies, though apparently not fully satisfactory to himself, is very likely the explanation which would be given to-day. Though expressed in different words, he recognized an increased electric density to exist at points, for he says: "The force with which the electrified body retains its atmosphere by attracting it, is proportional to the surface over which the particles are placed, that is, four square inches of that surface retain their atmosphere with four times the force that one square inch retains its atmosphere. And as in plucking the hair from a horse's tail a degree of strength not sufficient to pluck away a handful at once could yet easily strip it hair by hair, so a blunt body presented could not draw off a number of particles at once, but a pointed one, with no greater force, takes them away easily, particle by particle."

These, and other experiments on points not here given, had prepared the mind of Franklin for the invention of the lightning rod which followed soon after he had made his great discovery of the electrical nature of lightning; another illustration of the general principle that great inventions, like all notable performances, are results more of preparation than of inspiration.

THE LEYDEN JAR.

The marvelous properties of M. Muschenbroek's bottle, or the Leyden jar, especially excited the interest and attention of Franklin. He was led by most ingenious and logical experiments to the discovery of many of the laws of its action. He likewise, by his experiments on this, obtained most of the facts upon which he founded his very consistent and simple theory of electricity, a theory which was for many years the one universally accepted and the influence of which still pervades modern electrical ideas and language.

Some of the important conclusions regarding the Leyden jar to which he was led by his experiments may be summarized as follows:

I. The charge which is contained in the "bottle" (the Leyden jar) differs from the charge on a metal surface which becomes surrounded by an electric atmosphere in being "crowded into the substance of the former, the glass confining it."

II. The inside and outside of the jar have equal and opposite quantities of electrification. If the inside has a plus charge the outside has an equal negative charge.

III. To discharge the "bottle" communication must be made between the inside and outside coatings.

IV. The "electric fire" can not be forced into either the outside or inside without an equal quantity disappearing at the same time from the other side. "The fire only circulates," "so wonderfully are these two states of electricity, the *plus* and the *minus*, combined and balanced in this miraculous bottle."

V. The shock obtained from the bottle results only when the "fire" passes from

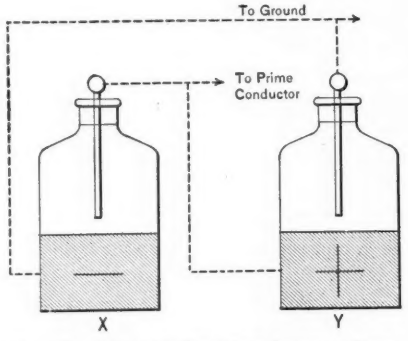


FIG. 2.—EQUALLY CHARGED LEYDEN JARS CONNECTED.

one coating of the bottle to the other through the body.

The above generalizations were arrived at after trying a large number of experiments; though some of the laws mentioned may have been wholly or partly understood before Franklin stated them they were nevertheless independently determined by him. We can take space to describe only a few of the experiments made. It may be mentioned that Franklin usually partially filled his jars with water to form the inside conductor or coating and thus he often speaks of the Leyden jar as a "bottle." That the charge is located in the glass he determined as follows. We quote his own words:

"Purposing to analyze the electrified bottle, in order to find wherein its strength lay, we placed it on glass, and drew out the cork and wire, which for that purpose had been loosely put in. Then taking the bottle in one hand, and bringing a finger of the other near its mouth, a strong spark came from the water, and the shock was as violent as if the wire had remained in it, which showed that the force did not lie in the wire. Then to find if it resided in the water, being crowded into and condensed in it, as confined by the glass, which had been our former opinion, we electrified the bottle again, and placing it on glass, drew out the wire and cork as before; then taking up the bottle, we decanted all its water into an empty bottle, which likewise stood on glass; and taking up the other bottle, we expected, if the force resided in the water, to find a shock from it, but there was none. We judged then that it must either be lost in decanting or remain in the first bottle.

"The latter we found to be true; for that bottle on trial gave the shock, though filled up as it stood with fresh unelectrified water from a teapot. To find, then, whether glass had this property merely as glass, or whether the form contributed anything to it, we took a pane of sash-glass, and laying it on the hand, placed a plate of lead on its upper surface; then electrified that plate, and bringing a finger to it, there was a spark and shock. We then took two plates of lead of equal dimensions, but less than the glass by two inches, every day, and electrified the glass between them by electrifying the uppermost lead; then separated the glass from the lead, in doing which what little fire might be in the lead was taken out, and the glass being touched in the electrified parts with a finger, afforded only very small pricking sparks, but a great number of them might be taken from different places.

"Then dexterously placing it again between the leaden plates, and completing a circuit between the two surfaces, a violent shock ensued, which demonstrated the power to reside in glass as glass, and that the non-electrics in contact served only, like the armature of a loadstone, to unite the force of the several parts, and bring them at once to any point desired; it being the property of a non-electric that the whole body instantly gives what electrical fire is given to, or taken from any one of its parts."

By many experiments from which we detect the following, Franklin determined the equal and opposite states of electrification of the inside and outside of the "bottle."

Two bottles, x and y, of equal capacity were connected up as indicated in Fig. 2 and charged equally but oppositely. Then the coatings of each were joined together and when the knobs were touched the two bottles were discharged into each other and left unelectrified, from which Franklin concludes that the "abounding" of fire in one is exactly equal to the "wanting" of fire in the other.

Again he found that a full charged bot-

tle divides its fire with an empty bottle. Franklin criticises the terms "charging" and "discharging" as being inaccurate, since after either process the same amount of fire exists in the bottle. He showed that the bottle is only discharged, either by degrees or suddenly, in the following ways:

A bottle is charged and placed on wax, G, Fig. 3. Then by touching either the knob or the coating the bottle can not be discharged. But if a bent wire, *c*, with a knob at each end is held by a piece of wax and one knob is touched first to the knob of the jar and then removed and the other knob touched to the coating, that by repeating the process many times the bottle is gradually discharged. If the wire is made to touch both the knob and the coating at the same time the jar is suddenly discharged with a flash and crack. Again, he showed that if an insulated person takes the bottle in his hand, and then, after being touched by a person standing on the floor, touches the knob of the bottle with his other hand, the bottle is wholly discharged with a shock to the person, who is left entirely unelectrified.

Franklin was also the first one to make that highly amusing experiment of the animated spider which is often reproduced in demonstration lectures on physics to-day. The knobs of several jars are charged, some positively and others negatively. The jars are placed on a table in irregular arrangement, a foot or so apart. A huge spider, with a body of cork and legs of linen thread, is suspended from the ceiling by a silk thread, so as to hang amid the knobs of the charged jars. The spider immediately begins to move incessantly among the knobs of the different jars. It will fly to one knob, grasp it with its legs, take a charge, then move from this knob and go to another charged oppositely, grasp it with its legs, and so on in a very animated way until the jars are discharged.

Some other experiments with the "miraculous bottle," first due to Franklin, can merely be mentioned.

He showed that when one coating of a Leyden jar was carefully insulated by setting the jar on a cake of wax it could not be charged.

A suspended thread is shown to be attracted by the outside coating of the bottle whenever the knob is touched, the bottle taking in "fire" by the thread as it loses it by the knob.

A suspended cork will play for a long time between the knob of a charged phial and another near-by knob joined by wire to the coating.

A plus electrified cork ball is repelled by a plus electrified body.

A plus electrified body is shown also to attract a cork ball which is in the common state or unelectrified, but will attract a negatively electrified cork ball to a greater degree.

Since Franklin conceives of two portions of the electrical fluid as repelling each other, he is somewhat at a loss to account for the repulsion of two negatively electrified bodies. He could, however, have shown that his theory accounted for this repulsion also, as being due to the attraction of the surrounding matter. This matter being in the common state would

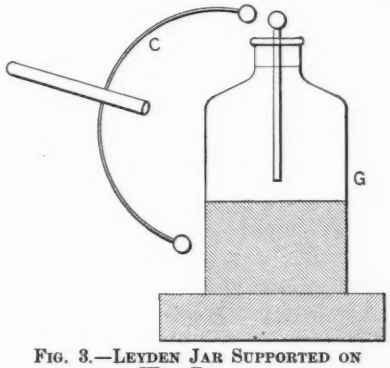


FIG. 3.—LEYDEN JAR SUPPORTED ON WAX PLATE.

attract the two negatively electrified bodies, and so cause them to separate as if mutually repelling. He showed that a person discharging the phial receives the same shock, whichever coating is touched first; also that the *direction* of the fire "being different in the charging will be different in the explosion."

I can not gather that Franklin ever clearly conceived why he chose to call the charge given a body by a rubbed piece of glass a plus or positive charge, and when later he learned that rubbed sulphur acquired a negative charge his one-fluid theory required some stretching to account for the new fact—but we will postpone till later our discussion of the nature and value of his theory.

Franklin, I think, was the first one to show that a number of phials could be charged at the same time and equally by connecting them in series or cascade. Such at least he describes to be his common practice.

He showed that reducing the thickness of the glass only made the jar charge the better. He then goes on to speak of the inside and outside surfaces of a charged phial standing ready, the one to give fire by the hook, the other to receive it by the coating. The state of electric strain is illustrated by a bent spring.

The side *y* is contracted, the side *x* extended. He says that both the extension of one side and the contraction of the other must alter at once for the spring to straighten. This conception of Franklin of the nature of the charge in a Leyden jar reminds one most forcibly of Maxwell's theory of a stress in the dielectric. The nature of this stress is not much clearer to-day than it was in 1750 to Franklin, and the fact that Franklin recognized the charge of a jar to have the nature of a stress existing in the glass, and not to consist in a surface layer of electric fluid on the conducting surfaces, shows, I think, remarkable insight. Franklin electrified a very thin glass bubble one inch in diameter and partly filled with water, and was astonished to find "in how small a portion of glass a great electrical force may lie," and to-day it is not less a marvel how enormous an electric stress a mechanically weak dielectric material may withstand.

Another of the discoveries to which Franklin's experiments on the Leyden jar led him was the clear perception of the two different classes of matter, to which he gave the names *conductors* and *non-conductors*. Regarding this he says we should consider electricity to be "pretty equally diffused in all the matter of this terraqueous globe." . . . "The electric matter passes through conductors as water passes through a porous stone or spreads on a wet stone, but when applied to non-conductors it is like water dropped on a greasy stone, it neither penetrates, passes through nor spreads on the surface, but remains in drops where it falls."

The air he considers as a non-conductor, but that the electric fluid can mix with it, and that the two do not displace each other. He proves this by filling a jar with a manometer, making it air-tight and charging it. No alteration in the height of the liquid column was discovered.

A correspondent of one of the automobile journals writing from Miami, Fla., says that an automobile livery has been established there and the machines are considerable of a mystery to the Seminole Indians. The squaws are said to appear somewhat afraid of the machine, while the braves are inquisitive to find out what makes it work. One of these valiant warriors, while taking a ride, leaped yelling from the machine and tumbled into a sand heap by the roadside, from which he jumped up and ran howling into the woods, where he secreted himself.

Telephone and Telegraph

A telephone exchange will be installed in the near future in Beechwood, Ill., and will connect with the wires of the Cairo Telephone Company's system.

The Farina & Vandalia, Mo., Telephone Company has been granted permission to install a telephone system between Vernon and Patoka, in Marion County, and Vandalia, in Fayette County.

The general offices of the Knickerbocker Telephone and Telegraph Company, of New York city, were recently removed from 418 Broome street, where they had been for some time past, to 100 Broadway.

A new telegraph line has been planned by the Russian Government to run between Odessa and Berlin to facilitate the telegraph service between those two cities. Work will be commenced in the Spring, as soon as the weather permits.

The recently incorporated Northfield, Minn., telephone exchange has been chartered to construct and operate telephone lines and exchanges with Northfield as its centre of activity. The company's indebtedness or liability is limited to $10,000.

A meeting of the Central New York Telephone and Telegraph Company was called in Utica, on March 29, for the purpose of voting on a proposition to increase the company's capital stock from $800,000 to $1,000,000. The result will be announced later.

A central station will soon be established in the town of Plattsburg, Ohio, by the United States Telephone Company, which a few days ago purchased private rights of way from property-holders, and which expects to give both local and long-distance service.

Mr. George Hoyt, of Cleveland, is interested in a telephone and telegraph company having a perpetual franchise in Cleveland, Ohio. It is understood that a controlling interest in this company is for sale. Cleveland seems to be quite a centre of telephone work at the present time.

A telephone franchise was recently granted by the common council of Rockford, Ill., and the Winnebago County Telephone Company, which, on getting the franchise, commenced incorporation proceedings, will soon begin to install a telephone system throughout the county.

A franchise has recently been secured by the Findlay, Ohio, Home Telephone Company for an exchange in Arcadia, which will be connected with the Findlay exchange. Construction work on the lines to Arcadia, Rawson, Vanlue, Benton Ridge and other towns in the vicinity will be commenced early in May.

All the long-distance connecting lines centering in it and the telephone exchange itself in Clinton, Tenn., have been purchased by the Cumberland Telephone Company, which is reported to have paid only $2,000 for them. The new owner will inaugurate important changes and improvements in the near future.

It has been decided by the South Dakota Central Telephone Company, of Aberdeen, to expend $20,000 in the extension of its lines, and construction work will be begun in the Spring. Aberdeen and neighboring towns on the system will be connected with St. Paul, Minn., Sioux City, Iowa, Sioux Falls and other places.

Reports from Shelbyville, Tenn., state that the Cumberland Telephone Company is extending its lines to all parts of the county. Many of the country stores are said to have taken instruments, and it is believed that it will be but a short time until every leading farmer in the country in the vicinity of Shelbyville takes advantage of the opportunity presented.

A mortgage was filed at Norfolk, Va., recently by the Southern States Telephone Company, a Maryland corporation operating exchanges in Norfolk and vicinity, to secure a bond issue of $150,000, of which $50,000 will be used in retiring a previous bond issue, and the balance in improving and extending the company's lines. It is understood that the connection by long-distance wires of many towns south of York, Pa., is proceeding, and that the Southern company will soon be a competitor in the southern states for a long-distance service with the Bell.

At a meeting of the Georgia Telephone Company, recently held in Savannah, President W. A. Bisbee was authorized by the directors to make extensive improvements and additions to the company's service in that city, at a total expenditure of about $50,000. The demand for telephone service is said to be rapidly increasing in Savannah, and the directors empowered the president to extend the lines wherever business demanded the expenditure of more money. An additional extension toward Collinsville will soon be made, and that, with other similar improvements, will reach a total of $50,000.

Reports from Tampa, Fla., state that Messrs. Brorine and Huffman have asked for a franchise for a new telephone exchange in that city. The gentlemen have a capital of $200,000 and promise underground wires and connections with all towns and hamlets within a radius of 50 miles as soon as such lines can be constructed. They also guarantee to establish connection between Tampa and Jacksonville in less than a year, and are said to represent an Ohio syndicate which is putting systems all through the South and Southwest. It is believed that the franchise will be granted, and if this is done, work will immediately be commenced on constructing the lines.

OBITUARY.

Dr. William F. Channing, a son of Dr. William Ellery Channing, died recently at the Perry Hospital in Boston, Mass., of pneumonia. Born in February, 1820, in Boston, he was educated at Harvard and the University of Pennsylvania. Dr. Channing never practised medicine, though that was the course he took in college, but was connected with Moses G. Farmer in the perfecting of the American fire-alarm telegraph, the two men patenting their system in 1857. In 1865 he patented a ship-railway for the interoceanic transit of ships and was also the inventor of a portable electromagnetic telephone, and has published several works on magnetism and electricity, being one of the first to apply electricity to therapeutics. The hand receiver on the telephone was his invention, and was purchased from him by the American Bell Telephone Company.

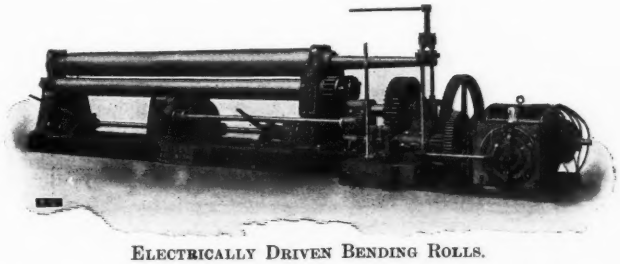
Leander D. Parker, who was for eighteen years general superintendent of the Postal Telegraph Company, died at his home in Evanston, Ill., recently. Mr. Parker resigned from his position with the Postal company in January, owing to ill health. He had charge of the construction of the western lines of the company when it was extending its system throughout the West, and first entered the telegraph service in 1855, serving as a military operator during the first three years of the Civil War. Mr. Parker was born in Canada in 1837.

Emile A. Shape, who was for many years chief operator of the Western Union Telegraph Company in Milwaukee, Wis., died suddenly from pneumonia on March 21. He was one of the oldest and best-known telegraphers in the United States, and during the Civil War was attached to General Grant's personal staff.

Electrically Driven Bending Rolls.

The rolls shown in the illustration are solid wrought-iron forgings, arranged in pyramid form, and have a capacity for bending plates up to 12 inches in width and five-eighths of an inch thick.

The lower rolls are geared together while the upper or bending roll is revolved by the friction of the plate in passing through. It is adjustable by power to suit the thickness of the plate and the radius to which it is to be bent. It has a hinged bearing at one end which may be turned down out of the way, while the other end has a long shank extending to a third support which retains the roll in position for the removal of rings or flues. This will be found a great advantage in boiler and other shops where plates are to be bent in a complete circle.



Electrically Driven Bending Rolls.

Midway between the housings a set of supporting rollers are placed to give additional stiffness to the lower rails. For very long machines, additional sets of rollers are added. The machine is firmly tied together by a heavy cast-iron soleplate. It is very strongly geared and all parts are made stiff and substantial.

Suitable levers and clutches are conveniently placed for the quick and easy control of all the operations.

The machine is driven by an 18-horsepower, reversible, constant-speed Bullock motor. For controlling the motor an automatic rheostat is used to prevent the operator from throwing on the full current too quickly and burning out the motor.

The field consists of a circular yoke of special steel. While particular attention has been given to a reduction in weight, it has not been at the sacrifice of efficiency. The pole-pieces, built up from soft sheet steel of the highest magnetic quality, are securely bolted to the yoke. The shape of the punchings is such as to produce a saturated pole-face, and this feature, coupled with carefully proportioned windings, is largely responsible for the sparkless operation of the motor, and is a feature greatly appreciated by engineers.

The field coils are machine wound and carefully insulated. The shunt and series coils of compound-wound machines are separately wound. The coils are slipped over the pole before it is bolted to the yoke, and, should it be necessary, are readily removed.

The armature core is built up from thin, carefully annealed sheet steel, possessing a high magnetic permeability. These disks are again annealed and then japanned. They are mounted upon the shaft and held firmly together by malleable iron end-plates. The windings, which are let into slots provided in the periphery of the armature core, are made of either copper bars or wire as best suits the requirements. The coils are machine formed, and after being formed are thoroughly insulated with mica and other high-grade insulations. They are then baked in steam-heated forms while under pressure, which removes all moisture and produces a perfect and very compact coil. The result is a coil that is less liable to be injured than when produced by the ordinary method, and one which requires no further insulation when placed in position on the core. The armature coils are held in position by wedges of hard, thoroughly dried wood, driven into notches provided near the top of the slots.

The commutators are built from drop-forged bars of pure Lake copper with selected mica insulation. They possess great durability and have an exceptionally even wearing surface for the brushes. The brush-holder is simple and highly efficient, giving absolutely no trouble. It is of the reaction type; no adjustment of the brushes is necessary, and when they are once set the motor will operate in either direction without sparking and under all variations of load.

The Fraldu-Colliery Company, Ltd., of Cardiff, Wales, is requesting plans, specifications and bids for a secondary haulage plant from the working faces to the end of the rope haulage, which is operated by steam, as electrical haulage has not yet been successfully applied in the southern part of Wales. The company requires absolute guarantees that the plant will be efficient, safe from explosion in a gaseous atmosphere, and considerably cheaper than haulage by compressed air. The collieries are at Pontycymer, near Bridgend, South Wales, and can be inspected by intending bidders.

PERSONAL.

Mr. Stephen L. Coles, managing editor of the Electrical Review, has resigned his connection with this journal, after 12 years' service, to enter other business. He will remain closely identified with the electrical field, in which he enjoys a wide acquaintance. Mr. Coles's former associates on the staff of the Electrical Review take this opportunity to express their good wishes for his success in his new enterprise and their regret at losing an esteemed and able coworker.

President J. L. Greatsinger, of the Brooklyn, N. Y., Rapid Transit Company, announced recently that he would take steps immediately to relieve the congested passenger traffic conditions at the Bridge termini, and stated also that the entire system would be electrically equipped by July 1. Within a few days he will start for an extended trip throughout the West.

Dr. Toshi Suzuki, the mining geologist of the Japanese Imperial Steel Works, was recently in the United States in the interest of the mining department of the works at Tokio. Dr. Suzuki is said to have been greatly pleased, and obtained matter which will be of value to him in the developing and working of the mines under his control on his return to Japan.

Mr. John Kilgour, the president of the Cincinnati, Ohio, Street Railway Company, has been made president and general manager of the City & Suburban Telegraph Association, succeeding the late George N. Stone. Mr. W. A. Blanchard succeeds Mr. Stone as director and Mr. Kilgour as treasurer of the association.

Mr. Smith H. Riker has recently resigned his position as wire chief with the Western Union Telegraph Company, at Syracuse, N. Y., where he has been, with but slight intermission, since 1883, to accept a similar appointment at Troy, N. Y., with the American Telephone and Telegraph Company.

At a recent meeting of the Prussian Academy of Sciences, the announcement was made that Sir George Gabriel Stokes, of Cambridge University, England, has been honored with the Helmholtz medal, which hitherto has been conferred only on Professor Virchow and Lord Kelvin.

Messrs. Deeley and Woolliscroft, the engineers of the Midland Railroad Company, of London, England, were recently sent to the United States to study American methods, including the adaptation of electricity to railroad operation.

THE LARGEST ELECTRICALLY OPERATED DRAWBRIDGE IN THE WORLD.

BY H. G. TYRRELL.

The new highway bridge across the Connecticut River, at Middletown, Ct., is 1,300 feet long, with a 26-foot roadway and provision for two six-foot sidewalks. Besides the street traffic it carries a line of electric railway, connecting Middletown with Portland. It consists of two fixed spans, 200 feet centre to centre of piers; two fixed spans, 225 feet centre to centre of piers; one draw span, 450 feet centre to centre of piers.

Up to the time of building the bridge, in 1896, communication between the two towns had been kept up by means of ferries. The amount of travel seemed to warrant the construction of a bridge, so that the Middletown & Portland Bridge Company was formed to build and maintain a toll bridge. The location selected was about on the line of the ferry, 850 feet up stream from the railroad bridge and 300 feet below the end of Willow Island. It will be seen that the position of the island, with the channel on the west side, required the draw span to be about in the centre of the river, thus making a symmetrical arrangement. The government required two clear waterways of 200 feet each, which fixed the length of the draw at 450 feet. This is believed to be the longest highway drawbridge in the world.

Notwithstanding its being 30 miles from the sea, there is a tide of two and one-half feet, and the highest known water-mark is 25 feet above low water. The floor of the bridge was placed six feet above the last elevation, making the distance from floor to low water 31 feet. At low tide the depth of water in the channel is 16 feet.

The width of bridge selected is that required for two lines of carriage travel and one line of electric cars. This required 26 feet from centre to centre of trusses. Provision is made on the floor-beams for connecting sidewalk brackets in the future. The floor of the bridge is designed to carry a live load of 100 pounds per square foot, 14-ton electric cars or a 10-ton wagon. The trusses are proportioned for a live load per foot of bridge of 1,500 pounds for chords and 2,000 pounds for web. The material used was iron for eye-bars and lateral rods, the balance—excepting machinery—being medium steel. The bridge throughout has a wood floor consisting of 4 by 14-inch yellow pine joist vulcanized, spaced two and one-half feet apart, and two layers of spruce plank. The lower is three inches thick, kyanized, laid diagonally, and the upper two inches thick, square across. Both layers are dressed on one side. The stringers for car track are 15-inch steel beams, weighing 42 pounds per foot. On each side of road is a lattice railing with a one and one-half-inch pipe top.

The proportions selected for the trusses are 200, fixed span, 12 panels, depth 21 to 37 feet; 225, fixed span, 12 panels, depth 21 to 37 feet; 450, draw span, 20 panels, 21 feet 3 inches, depth 21 to 55 feet; one panel, 22 feet.

The turntable is entirely rim-bearing. Eight loading-beams transfer the weight to 16 points on the drum, which is four feet deep, and 31 feet diameter. This stands on 64 cast-steel wheels, 8 by 16 inches, which run between cast-steel beveled treads two inches thick at centre. The lower tread rests on wrought-steel plates bolted to the masonry. This arrangement of turntable makes a simple construction, and is believed to be as effective for a highway draw as some of the more elaborate combinations of rim and centre-bearing turntables, which depend on their adjustment for an even distribution of load. The drum and wheels are secured in place to a centre casting by means of the usual radial braces and spider frame. This centre casting is set down six inches into the stone pier, and secured to it by means of eight bolts, one and one-half inches diameter and six feet long, built solid into the pier. This casting has a hollow centre for the passage of wires up to the bridge.

The draw is operated by three 25-horse-power electric motors of railroad type, one for turning, and the other two for blocking up the ends. Besides these there are a fourth motor and a duplicate set of turning machinery, all in place, which can be used in case of unbalanced wind pressure or a breakdown in the other machinery. These two sets can be worked independently or together at the will of the operator. Power is taken from the Middletown street wires, a cable being laid on the river bottom and brought up on the centre pier. This passes in a groove under the wheel track and up through the centre casting. The operating house stands on an overhead platform in the centre tower. It has large windows on four sides, and an over-hanging sunshade eave. The walls and floor are double thick, and it is provided with electric heat for cold weather. The platform is reached by means of a ladder from the bridge floor. It was originally intended that the closing of the gates should be done by the operator in the tower, and a complete design was made for electrically worked steel safety-gates. But on account of an accident to the substructure, involving extra expense, the steel gates and some other machinery were omitted.

As already stated, the blocking up of the

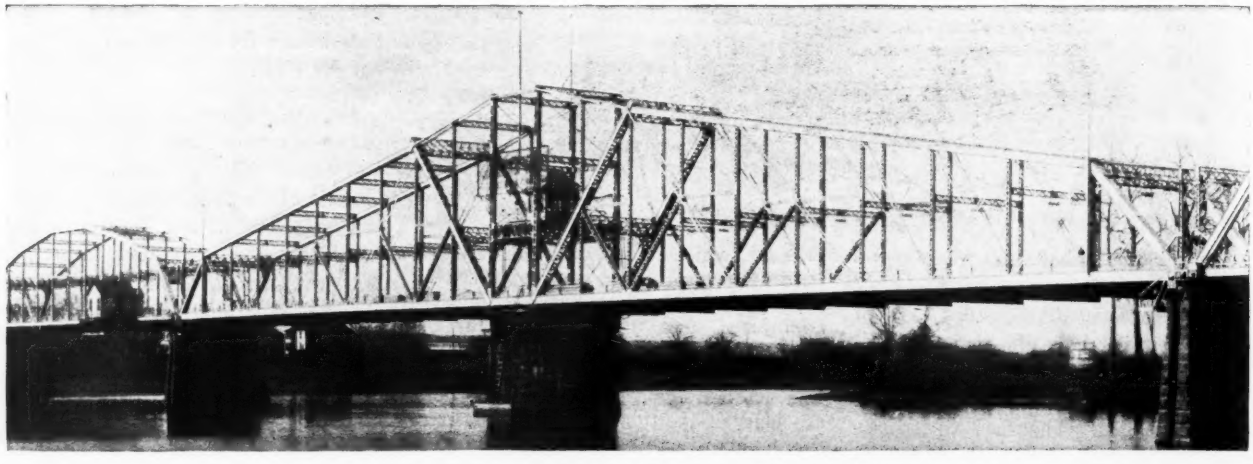


FIG. 1.—HIGHWAY BRIDGE OVER THE CONNECTICUT RIVER AT MIDDLETOWN.

ends is done by two separate motors at the ends of the draw, placed beneath the floor. It is not infrequent to bring power from the centre by means of a shaft, but experience shows that for long draw-spans this method is not satisfactory as too much power is lost by friction in the boxes. The calculated deflection of the ends was three and three-quarter inches, and after the bridge was completed and levels taken, the actual deflection was found to be three and seven-eighths inches.

Blocking up the ends is done by means of a pair of toggles at each corner. These are drawn together by two bronze nuts working on a right and left-hand screw that is turned by bevel gears from the motor. To prevent these nuts from jamming, there are electric signals that tell the operator when to shut off his power. As a general rule, it is intended simply to block the ends up tight. This requires but very little power. But as there is always the liability of the blocks becoming tight from change of temperature or other causes, the end machinery was proportioned to lift 50 tons at each corner, one and one-half inches in 10 seconds. This required 10 horse-power, but it was thought best to use the same kind of motor used at the turntable, giving interchangeable parts. To provide for expansion the end toggles rest on cast-steel rockers of 17½ inches radius, which in turn bear on cast-iron pier plates, blocked up to the right elevation with shims. The latch is an extra heavy swinging gravity latch, to which is attached a line of No. 10 wire passing over pulleys to the centre and connected by means of bell cranks with the operator's house. To open by electric power takes 30 seconds, and the power required to overcome an unbalanced wind pressure of five pounds on one-half of bridge is 30 horse-power. Ordinarily, however, in calm weather five horse-power is sufficient to turn. It was necessary to use about four times the amount of resistance ordinarily used on street-car work with the same motors, the reason for this being evident when the relative weight of bridge and car is considered. Both the centre and end sets of machinery are provided with clutches which can be thrown out of gear, and the operation performed by hand power. Working on 10-foot levers the bridge is turned by four men in eight minutes. There is a friction brake applied to a drum on the highest speed turning shaft. This and the other turning machinery, including the motor, are placed on the outside of the drum beneath the floor, in a machinery frame that can be sheathed in and protected from snow and ice. The whole bridge is well lighted with incandescent lamps, and has also the usual signal lights required by the government.

The foundation for this bridge consists of two abutments, four river piers and a circular draw pier, the maximum depth of water in the channel at low tide being 16 feet. All of the piers and the Middletown abutment stand on pile foundations. The Portland abutment is built on solid rock, found six feet below the natural surface of the ground. The masonry throughout is laid in regular courses, varying from 18 to 30 inches in thickness. The stone used is the celebrated Portland brownstone, taken from quarries about half a mile above the bridge site. Concrete was prepared by using one part of Portland cement, two parts of sand and four parts of broken stone. The draw pier has a batter of half an inch to the foot, and all others, including the abutments, are battered three-quarters of an inch per foot. The top of the timber grillage in all cases is a foot and a half below extreme low-water line. Apart from the draw pier, the Middletown or west abutment is the heaviest piece of work, containing 815 cubic yards of masonry.

As the turntable is entirely rim-bearing, the outside coping course is hammer-dressed to receive steel bed-plates which are held down by short bolts set into the stone. The pier is elevated six inches at the centre to secure drainage, and the centre casting is set down into the stonework six inches and anchored to it by bolts built solidly into the pier.

It will be seen from the engravings that the draw is built in without any fender pier and the span is reversible, excepting that the railway track is on one side. The whole bridge, not including the rebuilding of the west abutment or the earth filling at the ends, cost about $180,000.

The preliminary estimates, with number and length of spans, were determined in the estimating department of the Berlin Iron Bridge Company. The matter was then turned over to the writer, who was their assistant engineer. On going over the entire design the writer found it necessary to change the form and outline of both the draw and the fixed spans and to refigure and reproportion the members. He then proceeded to design the machinery and all other structural details connected with the work. Mr. Graves, of Hartford, was in direct charge of the foundation work, and John Devin was erection foreman for the superstructure. The owner of the bridge is the Middletown & Portland Bridge Company, for which F. L. Wilcox is treasurer.

FIG. 2.—OPERATING ROOM, MIDDLETOWN HIGHWAY BRIDGE.

British technical papers state that an English company proposes soon to build an electric circular railway in St. Petersburg, Russia, with several branch lines and a central station, providing a two-minute train service. In the city the line will run overhead on iron pillars and in the suburbs on embankments, being 92½ versts in length, crossing the Neva River and the canals on 11 bridges. A committee is said to have been appointed by the Russian Government to look into the project.

Delaware, Ohio, is said to be heated, lighted and supplied with power from one plant.

Electric Lighting

Five-year franchises have been granted by the city of Denton, Md., for an electric lighting plant which will be installed by outside contractors.

Fire recently damaged the electric light plant in Clyde, N. Y., so badly that it will be compelled to refit almost entirely, and in the meantime the town will remain dark. The damage is estimated at about $8,000.

San Jose, Cal., is debating the question of issuing $60,000 in bonds for an electric lighting plant, and C. M. Barker, the city engineer, is in charge of the matter at the present time.

By a unanimous vote of the citizens of the village of Thorpe, Wis., it was recently decided to construct a $6,000 electric lighting plant for the municipality and to operate it in connection with the local waterworks system.

The town council of Butler, Mo., recently decided to submit a proposition at the next town election for a $20,000 bond issue to provide for the equipment and installation of an electric lighting plant, as the two corporation plants which have up to the present time been in operation, have proven unsatisfactory.

A large electric lighting plant will be installed in Terre Haute, Ind., at the round house of the Southern Indiana Railway in that city. The system to be used will be incandescents and a large number of lights will be used in the round house, yards and general offices of the company.

An electric lighting plant, to furnish 125 lights, is being installed on the steam barge Orion, which was built at Green Bay, Wis., last Winter. The lights in the interior of the vessel will be incandescent and besides them several arc lights will be swung from the yardarms to light the wharves when the boat is loading or unloading at night.

A private electric lighting plant is contemplated by the trustees of the Indiana State Normal School, at Terre Haute, and as the building in which the plant will be located is already equipped with steam-power the trustees believe that the addition can be made without heavy expense and consider that a very desirable saving can be effected.

Reports from Everett, Wash., state that the electric lighting and street railway systems of that city, which were recently purchased by the Everett Improvement Company, are being entirely refitted. Plans for the improvement of the lighting system include the building of a power-house, centrally located, which will be nearly twice the size of the present station. The wiring throughout the entire city is to be also completely rearranged and many other important improvements inaugurated.

The citizens of Greenport, L. I., have been called upon to vote on the question of authorizing a bond issue of $12,000 to double the capacity of the electric lighting plant which is at present owned by the municipality. The plant is stated to have become self-supporting and there is such a demand for its service that the 129 lights now burning in the village are not sufficient to meet the requirements of the town, which desires a further extension of the plant.

Reports from San Juan, Puerto Rico, state that Mr. Justice Holt, in the United States District Court, has rendered a judgment in favor of the Western Electric Company against the Electric Light Company, of Mayaguez, for the sum of $24,403.58 with interest and costs. The justice's opinion states that the lien which was given by the Mayaguez company on its plant to secure the constructor was not discharged, and the date set for the sale of the plant at public auction is June 3, 1901.

An amendment to the city charter of Niagara Falls, N. Y., recently passed by the local authorities provided that all telegraph, electric light, telephone and other companies using electric wires for transmission of power for any purpose be compelled to place those wires underground. It is stated that there is no objection made to the amendment on the part of the local companies and if it becomes a law, as it is believed it will in the near future, the replacing of the wires will be pushed through with all speed.

Options have been secured on several pieces of property in the city of Indianapolis, Ind., by the Home Heating and Lighting Company, which expects to compete with the Indianapolis Light and Power Company for commercial lighting and power in the mile square. The company is said to have secured permission from the board of works to lay conduits in that territory, the alleys and streets through which its wires may run having been designated by the city engineer. During the Summer the company will put in a new downtown power-house.

A contract has recently been entered into between the Bloomington, Ind., Light, Heat and Power Company and the Kuhlman Electric Company, of Elkhart, for a number of transformers of 5,000-light capacity, to replace those now in use. The present lighting service has been found inadequate and the Bloomington company determined some time ago to inaugurate whatever improvements were necessary for making its system thoroughly reliable. In addition to the new transformers a circuit will be run from the power-house to the business district, connected in such a manner that it can be thrown on either of the three dynamos. About $25,000 will cover the total improvements. Mr. A. M. Barron is the general superintendent of the company.

President Maltby, of the Boston, Mass., Electric Light Company, in a recent interview is reported to have said: "Our business during the past six months has increased to such an extent that the directors felt justified in declaring yesterday an extra dividend of one per cent in addition to the regular quarterly of two per cent. The extra dividend is from the earnings of the past six months, and signifies nothing as to future disbursements. The statement to the effect that our dividends will hereafter be at the regular rate of three per cent is erroneous. Since the first of January our output of incandescent lamps has increased over 13,000. There is nothing to be said regarding consolidation matters. Negotiations have not been finally broken off, and no recent conferences have been held. The whole matter is on the shelf."

Incorporation articles were recently filed by the People's Electric and Power Company, of Kansas City, Mo., with a capital stock of $2,000. The incorporators of the company are H. C. Ward, C. E. Finley and C. H. Richert. A 50-year franchise has been obtained by the company which, according to its articles, is to construct, maintain and operate electric lighting plants and sell their products. One of the organizers of the company is said to have stated that its incorporation was the first step of a movement towards the organization of a large corporation which will have ample capital for the installation of a system to furnish light and power for the entire city. The present company expects to work in conjunction with the Kansas City Electrical Wire Subway Company.

Corporation News

CHICAGO, ILL.—The Thomas J. Peter Company. $10,000.

URBANA, ILL.—Urbana, Bellefontaine & Northern Railway Company. $50,000.

YOUNGSTOWN, OHIO—Youngstown Engineering Company. $50,000.

LIVONIA, N. Y.—Livonia Telephone Company. $1,000. Directors: E. A. Bronson, W. B. Thurston and others.

KIRKWOOD, PA.—Southern Telephone and Telegraph Company of Lancaster County. $10,000.

NEW PALESTINE, IND.—Sugar Creek Township Farmers' Telephone Company of Hancock County. $240.

PHILADELPHIA, PA.—The Rio Plata Electric Company has increased its capital stock from $100,000 to $500,000.

BURNSIDE, KY. — Burnside Electric Light and Power Company. $500. Directors not named.

NEW YORK CITY, N. Y.—Emporia Railway, Lighting and Repository Company. $150,000.

TRENTON, N. J.—Grand Cañon Copper Company. $250,000. Incorporators: J. E. Crossly, H. E. Brooks and others.

GREENVILLE, MD. — Greenville Telephone Company. $750. Incorporators: W. Woods, J. H. Taylor and others.

FRENCH LICK, IND.—Star Telephone Company. $2,000. Directors: L. Ellis, H. Roland and J. L. Sutton.

NASHVILLE, TENN.—Great Falls Power Company. $20,000. Incorporators: T. J. Kittrell, A. J. Dyer and others.

CHICAGO, ILL.—Automobile Multiplier Company. $10,000. Incorporators: E. Peycke, L. Sonnenschein and L. H. Clarkson.

RICHMOND, VA.—The Virginia & Little Indian Telephone Company has increased its capital stock from $600 to $5,000.

CAMDEN, N. J.—Shepard Engineering and Automobile Company. $600,000. Incorporators: F. R. Hansell, Max Phillips, P. W. Miller.

LYONS, N. Y.—Lyons Electric Railway Company. $45,000. Directors: C. A., D. E., C. F. and A. C. Lux, C. H. Ford, M. Witt and others.

ELIZABETH, N. J.—American Traction Company. $250,000. To operate automobiles. Incorporators: Herbert Knight, D. J. Newland and F. A. Raymond.

COVINGTON, KY.—Union Light, Heat and Power Company. $1,500,000. Incorporators: J. C. Ernst, C. E. Prior, J. T. Van Horne and C. W. Wetmore.

SEYMOUR, BAYLOR COUNTY, TEX.—Profitt Telegraph and Telephone Company. $10,000. Incorporators: J. W. Profitt, J. H. Glasgow and G. G. Garrett.

COOPER, DELTA COUNTY, TEX.—Cooper Electric Light Company. $12,000. Incorporators: Charles Tuttle, W. R. Evans and E. S. Kelley.

CINCINNATI, OHIO—Cincinnati & Columbus Traction Company. $10,000. Incorporators: H. Burkhold, F. O. Suire, P. C. and R. C. Swing and A. J. Becht.

COLUMBUS, OHIO—Lakeside, Napoleon & Western Electric Railway Company. $300,000. Incorporators: D. B. Brown, R. F. Muir and others.

TRENTON, N. J.—Federal Water-Power and Cable Company. $1,000,000. Incorporators: J. W. Avery, J. A. Hill, H. C. Brady and others.

ROCKFORD, ILL. — Winnebago County Telephone Company. $5,000. Incorporators: F. L. and Charles F. Tuttle and H. S. Hicks.

NEW YORK CITY, N. Y.—Grant Brothers Company. $25,000. To manufacture electrical machinery. J. A. and J. H. Graham and J. T. Booth.

MARKLEVILLE, IND.—Wildwood Telephone Company of Madison County. $500. Directors: J. and C. Biddie, E. Davis, L. Johnson and C. Fort.

NIAGARA FALLS, N. Y.—The Buffalo & Niagara Falls Electric Light and Power Company has increased its capital from $200,000 to $500,000.

WAUSAU, WIS.—Wisconsin River Valley Electric Railway Company. Incorporators: T. F. Frawley, C. D. Bundy and R. P. Wilcox. Capital not stated.

WARRINGTON, IND. — Warrington & Markleville Telephone Company. $1,000. Directors: S. J. Harlan, J. A. McDaniel and O. H. Morgan.

INDIANAPOLIS, IND. — Electrical Appliance Company. $5,000. Directors: E. E. and Susan Rines, C. C. and C. McCauley and J. E. Booth.

WHITEHALL, N. Y. — Consolidated Light and Power Company. $75,000. Directors: C. F. King, J. H. Barker, J. M. Cronin.

COVINGTON, KY.—Kentucky Improvement Company. $15,000. To establish telephone service. Directors: J. H. Griewe, J. J. Weaver and others.

FARIBAULT, MINN.—Northfield Telephone Exchange Company. $15,000. Charles and Phoebe Church and H. L. Frye, incorporators.

TRENTON, N. J.—Consolidated Railway, Lighting and Refrigerating Company. $6,000,000. Incorporators: W. C. Stemmerman, John H. Thompson, Jr., and Clifford W. Perkins.

WEST POINT, KY.—West Point Electric Company. $5,000. Officers: J. L. Williams, president; A. J. Turpin, vice-president; W. L. Weller, Jr., secretary and treasurer.

ATCHISON, KAS.—Atchison Railway, Light, Heat, Power and Water Company. $800,000. Incorporators: B. P. Waggener, J. A. Bendure, W. P. Waggener and others.

NILES, OHIO—Wiswell-Pritchard Electrical Manufacturing Company. $30,000. W. H. and P. J. Pritchard, F. W. Stillwagon, H. W. Wiswell and C. M. Wilkins, incorporators.

ONEIDA, N. Y.—Representatives of the Standard Oil Company recently purchased the Oneida Street Railway Company. The consideration is stated to be about $25,000.

CHARLOTTE, N. C.—James B. Curtis, representing the Curtis Syndicate, of Newark, N. J., is reported recently to have purchased the Queen City Telephone Company for $23,000 at receiver's sale.

FREEPORT, ILL.—The local street railway system and electric lighting plant were recently sold at receiver's sale to Charles Miller, of Franklin, Pa., who represented the bondholders, for $75,000.

DETROIT, MICH. — Capital Electric Manufacturing Company. $30,000. Paid-up stock, $20,000. Incorporators: A. L. Bresler, T. J. Rakestram, W. J. Bowen and E. A. Bresler.

NEWARK, N. J.—The New York & New Jersey Telephone Company has increased its capital stock from $8,000,000 to $15,000,000. The papers certifying the increase were signed by Alexander Cameron and Henry S. Snow, directors.

DOVER, N. H.—Concord, Dover & Rochester Electric Railway Company; $400,000. Dover, Somersworth & Rochester Street Railway Company; $300,000. Wallace D. Lovell is behind the capitalists who incorporated the two roads, which are to be united.

BOSTON, MASS.—Dividends have been declared by the following companies: American Telephone and Telegraph Company, regular quarterly, one and one-half per cent; payable April 15 to stock of record of March 30; books close April 1, open April 15. Regular quarterly dividend of $2 and extra dividend of $1 by the Boston Electric Light Company, payable April 15 to stock of record April 1.

BOSTON, MASS.—Preferred stock valued at $3,000,000 will be disposed of by the Worcester Traction Company to the syndicate now controlling all the Worcester street railways. The traction company's new directors are: T. J. Coolidge, Jr., and F. W. Kendrick, who fill the places of T. C. Barr, of Newark, and E. J. Moore, of Philadelphia. Vermilye & Company, of New York city, is acting for the purchasing syndicate.

Electric Railways

The power-house of the Galveston City Railway Company, which was destroyed by the storm which last year wiped the city out of existence, is soon to be rebuilt, and will cost about $100,000.

The *Lokal-Anzeiger,* of Berlin, Germany, recently stated that the city had purchased the street car lines owned by Siemens & Halske for a consideration of 10,000,000 marks ($2,380,000).

Municipal ownership of the street car lines, to begin with 1902, is said to be one of the problems under consideration by the city authorities of San Francisco, Cal.

London, England, reports state that Mr. Charles T. Yerkes recently paid £2,000,000 cash to secure control of the underground railways in that city, which are capitalized at £24,000,000.

At a recent meeting of the stockholders of the Inland Traction and the Allentown & Coopersburg Street Railway companies, held at Souderton, Pa., it was decided to consolidate the two companies. By this merger the Inland company secures a direct route to Allentown.

Advices from southern New Jersey state that the Cape May, Delaware Bay & Sewalls Point Railway has been acquired by ex-Senator L. E. Miller, of Cape May, for $90,000. The road is a trolley system seven miles long and operates along the ocean front.

A company is being organized in Canaan, Ct., for the construction of an electric railroad from the Massachusetts state line to Bridgeport, a distance of 70 miles, the plan being to have the road connect with the proposed Berkshire line from the state boundary at Pittsfield, Mass., and thus, with its connections, form a continuous line to New York.

Mr. Justice Ricks, of the United States District Court of Cleveland, Ohio, handed down a decision March 11, making unconstitutional the three-cent street car-fare ordinance which was passed by the city council two years ago, holding that the ordinance interfered with the existing contracts. The suit will be carried to the higher courts.

Plans were recently filed by the chief engineer of the Manhattan Railway Company, of New York, for a new two-story brick station to be used for storing and distributing energy for the new third-rail system with which the elevated road is being equipped. The station, which will be erected on the west side of Third avenue just north of 161st street, will cost $31,000.

Reports from Joplin, Mo., state that work has been begun on constructing the Mineral Cities Electric Railroad, which, when completed, will be 60 miles in length, connecting the important towns in the Kansas coal district with the mineral cities in southwestern Missouri and southeastern Kansas. The capital stock of the road is $500,000 and F. M. Moore, of Joplin, is its general manager.

Press despatches from St. Petersburg, Russia, state that the River Neva is so frozen that electric street car lines traverse the ice at three different points, and if one is disinclined to ride in them, a less sedate but more exhilarating means of crossing is to be had, as there are crowds of peasants standing at the ends of the streets eagerly bidding for the privilege of pushing one across for 10 copecks, about five cents.

Reports from Boston, Mass., state that the Boston elevated road will be in operation by May 1, and a section of the line at Charlestown will be set aside for the instruction of motormen. The line to be used for this purpose will be the Sullivan Square-Dudley street section. It is stated that steel for the elevated structure was contracted for at two and three-eighths cents per pound and that to-day steel could not be bought for twice that price owing to the advance.

A formal organization of the Cleveland & Southern Railroad has recently been effected and W. H. Lamphrecht elected president; A. H. Pomeroy, vice-president, and T. T. Pomeroy, secretary and treasurer. The road will extend, when built, from Cleveland through Berea, Medina, Wooster, Creston, Seville and Lodi to Wadsworth. By means of the traffic arrangement the rails of the Cleveland, Elyria & Western will be used between Cleveland and Berea, leaving 60 miles of track to be constructed. It is thought that the road will be in readiness within a year. Its capitalization will be $1,500,000 in stocks and the same amount in bonds.

The purchase of the Wyandotte & Detroit River Electric Railroad by the Detroit United Railway is considered by local newspapers to be part of a plan for one of the greatest electric railroad projects in the United States. The plan is believed to be that of having an electric line in operation during the coming Summer between Detroit and Buffalo. In order to compete successfully with the steam lines, the cars are to have a speed of 50 miles an hour, and the company is believed to be backed up by the Everett-Moore syndicate, with a capital of $4,000,000 in stock and $4,000,000 in bonds. It is stated that none of the stock will be put on the market, but will be taken up by private subscription.

A company may soon be incorporated with a capital of $3,500,000, all of which will be subscribed as soon as the franchise is granted, for the purpose of constructing an electric railroad from Rochester to Niagara Falls. The officers of the company are: President, Allen C. Beach, Watertown; first vice-president, Charles S. Baker; second vice-president, Joseph C. Tone; secretary, George Moss; treasurer, George L. Brown; chief engineer, W. C. Gray, all of Rochester. The directors are Allen C. Beach, Watertown; William H. Gillette, Charlotte; Charles S. Baker, George L. Brown, George Moss, Milton Clark, George A. Brooks, Henry D. Quinby and William C. Gray, all of Rochester. The total length of the proposed road is 120 miles, 86½ to Niagara Falls and 33½ to Buffalo from that point. The estimated cost of construction is $3,000,000.

The city council of Colorado Springs, Colo., recently granted to Mr. W. S. Stratton a valuable street railway franchise. The life of the franchise is 25 years, and a $10,000 bond will be given for the payment of any suits. The company agrees to run an electric sprinkler over its system 10 hours every day, saving the city $5,000 per year, and transfers will be given to all of the company's lines, except where they parallel one another. The maximum fare will be five cents, and 22 tickets will be sold for $1. Construction work must commence within six months. The franchise is now said to be conditional upon the written consent of a majority of property owners whose buildings front the streets over which the lines will be laid.

A comprehensive plan for the construction of a great system of electric railways has been formed by the St. Louis, Mo., & Belleville Traction Company, which expects to build its extensions to different St. Clair County towns and to a number of villages in other counties. From Belleville lines will probably be built to Mascoutah and Freeburg, and the company is also considering the advisability of constructing other branches to Collinsville, Edwardsville, Waterloo and Red Bud. It will probably be 1903 before the Red Bud and Waterloo lines materialize, but the plan as outlined, having been under consideration for some time by the officers of the company, will be carried out in the end.

An Enclosed Natural Draught Water-Cooling Tower.

For a number of years the Wheeler Condenser and Engineering Company, of New York, has been building water-cooling towers for cooling circulating water in power plants. In its first designs a power driven fan for supplying currents of air for reducing the temperature of the water was employed, but last year the company brought out a new design in which the fan was dispensed with and the water was cooled by permitting it to trickle over the meshes of galvanized-iron wire mats, the surfaces of which were entirely exposed to the atmosphere. As a development of this type, the company is now placing upon the market a fanless form of tower in which the mats are enclosed in a steel-plate case or shell, and having in addition a steel flue, reaching a total height of from 75 to 100 feet above the ground, causing a strong draught of cool air to pass over the surfaces of the mats at all times.

This flue or chimney design of tower covers but little ground area and can therefore be used to great advantage where it is necessary to economize ground space, and its extreme lightness permits it to be installed upon roofs if necessary. It possesses the additional advantages of carrying away any undesirable vapors that might arise from the circulating water.

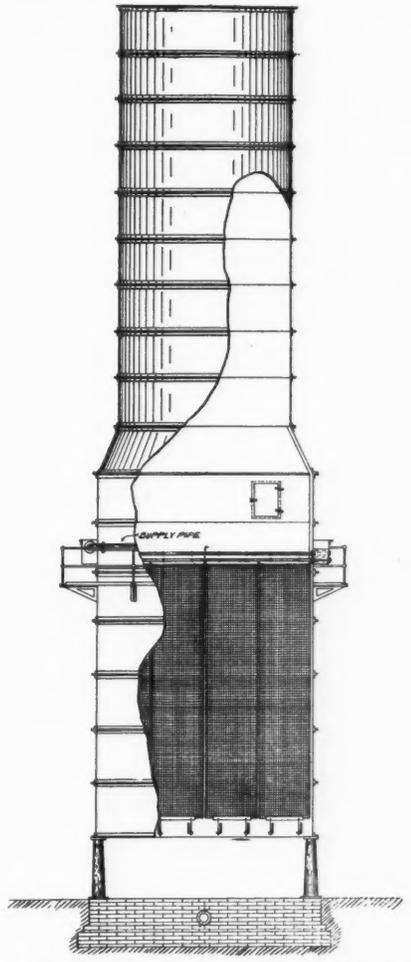
The mats in the new form of tower are practically the same as those supplied in the previous design of Barnard water-cooling towers and consist of galvanized wire, woven into mats of small meshes, over which a thin film of water passes, so that each drop of water is brought into contact with the circulating air, causing a rapid and positive lowering of the temperature.

Being self-operative, the new enclosed fanless tower is claimed practically to do away with all expense save the initial cost of installation.

Wall Street and the Electrical Stock Market.

On the New York Stock Exchange, General Electric closed the week at 215 bid and 217 asked, indicating a gain of 1 point. Metropolitan Street Railway, of New York, closed at 166 bid and 166½ asked, showing a gain of 2¾ points. Brooklyn Rapid Transit closed the week at 83 bid and 83¼ asked, showing a gain of ¼ point. Third Avenue Railroad closed at 122 bid and 124 asked, indicating a gain of ½ point. Manhattan Railway, of New York, closed at 127 bid and 127¼ asked, showing a gain of 1¾ points for the week.

On the Boston exchange, American Telephone and Telegraph closed the week at 167 bid and 168 asked, showing a loss of 1 point. Erie Telephone closed at 49 bid and 50 asked, indicating no change for the week. New England Telephone was not quoted.



Enclosed Natural Draught Water-Cooling Tower.

On the Philadelphia exchange, Electric Storage Battery was not quoted. Electric Company of America closed at 8¼ bid and 8½ asked, showing a loss of ⅜ point. Union Traction closed at 31½ bid and 31¾ asked, showing a gain of ¼ point for the week.

On the curb, or outside market, in New York, Electric Vehicle closed at 10 bid and 13 asked, showing a loss of 4 points. Electric Boat closed the week at 24 bid and 25 asked, indicating a gain of 1 point. Consolidated Equipment closed at 8¼ bid and 8½ asked, showing a loss of 3¼ points for the week.

Wall street, March 30.

A municipal electric lighting plant is contemplated by the common council of the town of Wenatchee, Wash.

Shunts for Switchboard Instruments.

In modern installations where large currents are measured the most approved form of amperemeter is an instrument of the potentiometer type using the fall of potential across a known small resistance as a measure of the current flowing in it. The manufacture of these resistances, or amperemeter shunts, has grown to be an important branch of switchboard building. The illustration herewith shows a type recently placed on the market by Messrs. Machado & Roller, of New York, general sales agents for the Whitney Electrical Instrument Company. The shunts are

Amperemeter Shunt.

made to give a drop of 50 millivolts at full rated load, and a metal having half the temperature coefficient of copper is used in their construction. Large radiating surface is attained by the design shown in the illustration, and it is claimed that the shunts can carry full rated load continuously without overheating. They are made in sizes of from 100 amperes to 10,000 amperes capacity.

Wireless Telegraphy in War Time.

A British contemporary says that the decision of the Admiralty with regard to utilizing wireless telegraphy for naval signaling purposes in war time testifies to the fact that the government has fully recognized the value of this system of signaling. Stations for this purpose are to be established, it has now been decided, at Culver Cliff, Dover, Portland Bill, Rame Head, Roche Point, Scilly Isles, Gibraltar and Malta. These two latter stations will, of course, be for use in connection with the Mediterranean and Channel fleets. As to the English stations, Culver Cliff is to be in direct communication with Portsmouth and Rame Head with Plymouth. By these means the naval commanders-in-chief at these ports may receive rapid and continuous information of what is happening in the outlying portions of their command. Special staffs for peace and war will be allocated to each station.

A lighting plant will soon be installed in Yorktown, Tex., by a Mr. Clark, of Galveston, who expects to put about $8,000 in the system.

Industrial Notes

THE MORRIS ELECTRIC COMPANY, 15 Cortlandt street, New York, is the sales agent for the Monarch insulating paint.

THE AMERICAN BRIDGE COMPANY states that it has received a contract for 36 steel bridges from the Chicago, St. Paul & Missouri Railway Company.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is carrying a full stock of swinging ball lightning arresters, so that orders can be shipped the same day they are received.

THE VINDEX ELECTRIC COMPANY, Chicago, Ill., is mailing its catalogue of transformers and will be pleased to send it upon application to any one interested. The book is worth examination.

THE DIEHL MANUFACTURING COMPANY, of Elizabethport, N. J., has just filled a very large order for ceiling fans and electroliers of unique and handsome design to be installed in the imperial palace at Formosa.

THE SHELBY STEEL TUBE COMPANY, New York and Pittsburgh, announces that it will esteem the address of all communications regarding sales and orders to its New York office as a favor, as this will considerably expedite the filling of such orders.

THE GARTON-DANIELS COMPANY, Keokuk, Iowa, is mailing a circular of its G. D. extension ringers. The folder contains much matter of interest and is well illustrated. "No magnets" is the motto stamped over each illustration of the ringers.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, Pa., has recently closed a contract with a local electric railway in Hamilton, Ontario, for the installation of a battery of chloride accumulators of 220 elements to give a discharge rate of 100 amperes.

THE INTERSTATE ELECTRIC COMPANY, Cleveland, Ohio, has made the following announcement: "Notice is hereby given that the Interstate Electric Company has discontinued its business. All creditors have been paid in full, and no debts will be contracted in the future."

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has just issued a circular with an excellent line of illustrations showing its fan motors in all their applications, and offers to furnish electrotypes, without cost, to any of its customers who care to use them.

THE AMERICAN ELECTRIC TELEPHONE COMPANY reports that it has recently installed additional central-energy switchboards in the following places: Bowling Green, Ohio, 150 drops; Salem, Ohio, 100 drops; East Liverpool, Ohio, 100 drops; Wellsville, Ohio, 100 drops; Rome, N. Y., 125 drops.

THE CLINTON GAS LIGHT AND COKE COMPANY, Clinton, Iowa, is asking for bids on a lot of second-hand electrical machinery and desires to purchase in addition a large quantity of new material, including copper and galvanized wire, insulators, bolts, screws, etc. Full particulars on application.

THE M-B ELECTRIC COMPANY, 203 Franklin avenue, Cleveland, Ohio, is issuing circular matter regarding isolated electric light plants, which are said to be especially adapted for residence work. They are now made in 5 and 10-light sizes, but the company expects shortly to increase this to larger capacities.

THE SPRAGUE ELECTRIC COMPANY, New York city, has issued bulletin No. 205 dealing with Lundell motors in all types and for all purposes. The pamphlet will be mailed upon application to the company and contains not only full descriptive matter on motors but also describes the Lundell controller at some length.

THE BURNLEY BATTERY AND MANUFACTURING COMPANY, Painesville, Ohio, manufacturer of dry batteries and the Burnley soldering paste, states that it is about to commence action at law to vindicate its rights on the paste question. This company mentions that during the year 1900 it sold 250,000 boxes of the Burnley soldering paste.

ROSSITER, MACGOVERN & COMPANY, Incorporated, New York and Brooklyn, is mailing its catalogue of electrical and steam machinery for March. The little book contains much matter of interest and is very comprehensive, the machines included running all the way from large-sized generators and street cars to small instruments and pulleys.

DALLETT & COMPANY, 201 Walnut place, Philadelphia, Pa., is issuing illustrated bulletins relating to its business of electric railway equipment and old railway material, of which it makes a specialty. The firm has a great many bargains such as alternators and generators, and is just now making a leader of open trolley cars, in which it has a number of unusual bargains.

THE WESTERN ELECTRIC COMPANY, of Chicago, Ill., is mailing bulletins containing much information of interest regarding the large lines of construction material carried by that company for central station and street railway work. The bulletins are neatly gotten up and contain much pertinent matter. They will be mailed to any one interested upon application to the company.

THE BROWNING MANUFACTURING COMPANY, Milwaukee, Wis., manufacturer of motors and dynamos, in the smaller sizes, has now the following representation: Mr. M. E. Baird, eastern manager, 321 Havemeyer Building, New York; Kohler Brothers, agents, 1804-1812 Fisher Building, Chicago. This company has recently issued some interesting bulletins relative to these small motors and dynamos.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa., state that the chief inspector of the Metropolitan Street Railway Company, of New York, who was started two years ago as a student of the schools, says that the instruction has proved invaluable to him in his work and that many employés of the same company who have taken the courses provided by the schools have been greatly benefited by their studies.

"A NEW ELECTRICAL CONVENIENCE" is the title of the slips being sent out by the Western Electrical Supply Company, St. Louis, Mo., illustrating the company's new taps, which make it possible to connect additional wires to lighting fixtures already in use. The taps are said to be most convenient for use with table lamps, fan motors, cooking utensils, heating pads and curling tongs. Full particulars and prices will be mailed on application to the company.

MR. EDWIN REYNOLDS, vice-president and general superintendent of the E. P. Allis Company, Milwaukee, Wis., was recently given a testimonial on the occasion of his 70th birthday and what is said to be the finest office desk in the world was presented to him by the officers and employés of the commercial institutions in which he is interested. The furniture indicated was made for exhibition at the World's Fair and has since then been displayed in Europe. It is stated that the desk alone cost $1,500.

THE WILLIAMS-ABBOTT ELECTRIC COMPANY, Cleveland, Ohio, has largely increased its force of workmen and is now running day and night. General Manager Dodge, of the company, states that the number is three times larger than it was three months ago, this being necessitated by the fact that there has been an increasing demand for the company's apparatus. It is also expected that the company will soon be able to show some new designs in the near future in telephone and switchboard work.

THE HELIOS-UPTON COMPANY, in addition to its Chicago factory at 222 Fullerton avenue, has opened a downtown office in the Marquette Building in that city. This company's main offices are in Philadelphia. In addition to being extensive manufacturers of arc lamps, both alternating and direct-current, the company has been for a year or more large makers of storage batteries for both automobile and central-station purposes. A number of plants have been installed during the past year, a notable one being for the Kansas City Electric Light Company, Kansas City, Mo. The fine country residence of Mr. H. N. Higinbotham, at Joliet, Ill., has been supplied with a complete installation of the Helios-Upton battery.

THE OLDS MOTOR WORKS, Detroit, Mich., has recently issued a neat folder descriptive of its electric and gasoline vehicles and its gasoline engines. The company builds engines not only for automobiles but also for marine purposes, and will mail its catalogue of such machines upon application. The small folder at hand contains numerous illustrations showing the adaptability of the Oldsmobile for different purposes. Among the pictures shown is a machine carrying a load of 2,100 pounds, although this machine is light enough to be carried by two men; another one climbing a frozen embankment, towing a snowplow, running in deep snow, starting with the rear wheels in a deep ditch, writing the name of the machine in snow and performing various other feats.

THE ERICSSON TELEPHONE COMPANY, 296 Broadway, New York, has issued Part 5 of the Ericsson series. Part 5 contains an exhaustive description of wire transposition on telephone circuits, and is recommended by the company as being of interest and value to all telephone men. A supplement is furnished with the folder illustrating one of the Ericsson multiple switchboards, representing a section of one of the multiple switchboards which was installed at Pittsburg, Kas., by the Pittsburg Telephone Company. On the other side of the supplementary sheet is a representation of the transpositions effected by the Ericsson method on a 12-wire line. The little book will be mailed upon application to the company by any one interested.

"FIFTEEN MILLION FEET UNDERGROUND" is the title of a catalogue just issued by the McRoy Clay Works, Brazil, Ind., and New York city. The book is one of the handsomest general catalogues that has been seen in a long time, being bound in pale yellow embossed paper stamped in gold and bronze, and containing a great number of engravings showing installations of the McRoy conduits in cities from the far northwest to the extreme southern end of the country. McRoy conduits are too well known to need any description, and the catalogue is rather in the nature of a list of installations under all conditions than a particularized schedule of the conduits themselves. The book is being sent out in a neat little box bearing upon its face the name "Tanagra," and the embossed figure of a woman, the whole being of the same color as the book itself. It will be sent to engineers and other parties interested upon application to the company.